No. : OM-E3292-2F

# FURUNO

# OPERATOR'S MANUAL

## MARINE RADAR

## MODEL FR-602D

FURUNO ELECTRIC CO., LTD.
NISHINOMIYA, JAPAN

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PRINTED IN JAPAN

# CONTENTS





# SPECIFICATIONS OF FR-602D

## SCANNER UNIT

1. Radiator: Slotted Waveguide Array (housed in radome)
2. Radiator Length: 80cm
3. Horizontal Beamwidth: 2.7°
4. Vertical Beamwidth: 25°
5. Sidelobe Attenuation:
   Within ± 20° of mainlobe: -23dB
   Outside ± 20° of mainlobe: -26dB
6. Polarization: Horizontal
7. Antenna Rotation: 24 r.p.m. nominal

## TRANSCEIVER MODULE (Contained in radome)

1. Transmitting Tube: Magnetron 9M302/E3513, 9M332 or MG5251
2. Frequency & Modulation: 9410MHz ± 30MHz, PON
3. Peak Output Power: 3kW nominal
4. Pulselength & Pulse Repetition Rate:

| Range | 0.25 | 0.5 | 1 | 2 | 4 | 8 | 16 | 32 |
|---|---|---|---|---|---|---|---|---|
| Pulse Repetition Rate | Approx. 3360Hz | | | Approx. 840Hz | | | | |
| Pulselength | 0.08us (Short) | | | 0.5us (Long) | | | | |

5. Modulator: SCR Line Type Pulse Modulator
6. I.F.: 40MHz
7. Tuning: Manual
8. Receiver Front End: MIC (Microwave IC)
9. Bandwidth: 7MHz/3MHz
10. Duplexer: Circulator with diode limiter

## DISPLAY UNIT

1. Indication System: Raster Scan, Daylight Display
2. Picture Tube: 9-inch rectangular CRT

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3. Range (nm) | 0.25 | 0.5 | 1 | 2 | 4 | 8 | 16 | 32 |
| 4. Range Ring Interval (nm) | 0.125 | 0.125 | 0.25 | 0.5 | 1 | 2 | 4 | 8 |
| 5. Number of Rings: | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

6. Bearing Resolution: 2.7°
7. Bearing Accuracy: Better than 1°
8. Range Discrimination: Better than 25m
9. Minimum Range: Better than 25m
10. Range Ring Accuracy: 1.5% or 70m, whichever is the greater.
11. VRM Accuracy: 1.5% or 70m, whichever is the greater.
12. Mark Indication: Heading Mark, Bearing Scale, Range Ring, VRM, EBL, Alarm Zone
13. Numeral/Character Indication: Range, Range Ring Interval (RINGS), EBL, VRM, Interference Rejection (IR), ST-BY, Rain Clutter Rejection (FTC), Alarm (ALARM)
14. Interference Rejector: Built in
15. Radar Alarm: Built in

ENVIRONMENT CONDITION

1. Vibration:

| Vibration Freq. | Total Amplitude |
|---|---|
| 1 to 12.5Hz | ± 1.6mm |
| 12.5 to 25Hz | ± 0.38mm |
| 25 to 50Hz | ± 0.10mm |

2. Ambient Temperature: Scanner Unit -------- -25°C to +70°C
Display Unit -------- -15°C to +55°C
3. Humidity: Relative humidity, 93% ± 2% at +40°C ± 3°C

POWER SUPPLY & POWER CONSUMPTION

10.2VDC - 40.0VDC, 43W or
100/110/115/220/240VAC, 50/60Hz, 1ø (Rectifier needed)





EQUIPMENT LIST

| No. | Name | Type | Weight (kg) | Q'ty |
|---|---|---|---|---|
| 1 | Scanner Unit | XC1P9N2N9D1 | 19 | 1 |
| 2 | Display Unit | RDP-040 | 6.9 | 1 |
| 3 | Accessories | FP03-02000 | | 1 set |
| 4 | Standard Spare Parts | SP03-02600 | | 1 set |
| 5 | Installation Materials | | | 1 set |

OPTIONAL SUPPLY

| No. | Name | Type | Weight (kg) | Q'ty | Remarks |
|---|---|---|---|---|---|
| 1 | Rectifier | PR-62 | 3.0 | 1 | AC mains only |
| 2 | Power Cable | VV-S 2.0x2C | | 1 | Cable length:5m |
| 3 | External Buzzer | OP03-21 | | 1 | For alarm |

ACCESSORIES (Type: FP03-02000, Code No.: 000-081-029)

| No. | Name | Type | Code No. | Q'ty |
|---|---|---|---|---|
| 1 | Bracket Assy. | FP03-02010 | 008-204-980 | 1 |
| 2 | Washer | 8.2x30.0x1.0 | 000-800-486 | 2 |
| 3 | Knob Bolt | KG-B3 M8x25 | 000-800-964 | 2 |
| 4 | Hood Assy. | FP03-01620 | 003-160-660 | 1 |
| 5 | Panhead Tapping Screw | 6x20 SUS304 | 000-800-414 | 5 |
| 6 | Flat Washer | M6 SUS304 | 000-864-129 | 5 |

STANDARD SPARE PARTS (Type: SP03-02600, Code No.: 000-081-370)

| No. | Name | Type | Code No. | Q'ty |
|---|---|---|---|---|
| 1 | Fuse | FGMB 10A AC125V | 000-104-815 | 2 |

INSTALLATION MATERIALS

For Display Unit

| No. | Name | Type | Code No. | Q'ty | Remarks |
|---|---|---|---|---|---|
| 1 | Connector | FM-142P | 000-511-406 | 1 | For power cable |
| 2 | Signal Cable Assy. | S03-11-10 (10m) | 008-204-690 | 1 | To be selected (With connector at display end) |
| | | S03-11-15 (15m) | 008-204-700 | | |
| | | S03-11-20 (20m) | 008-204-710 | | |
| | | S03-11-30 (30m) | 008-204-720 | | |

For Scanner Unit (Type: CP03-02701, Code No.: 008-206-950)

| No. | Name | Type | Code No. | Q'ty | Remarks |
|---|---|---|---|---|---|
| 1 | Crimp-on Lug | FV5.5-4 | 000-538-122 | 1 | |
| 2 | Crimp-on Lug | FV1.25-3 RED | 000-538-113 | 20 | |
| 3 | Fitting Metal | ML | 000-570-342 | 1 | |
| 4 | Hex. Bolt | M12x60 SUS304 | 000-862-191 | 4 | |
| 5 | Hex. Nut | M12 SUS304 | 000-863-112 | 4 | |
| 6 | Flat Washer | M12 SUS304 | 000-864-132 | 4 | |
| 7 | Spring Washer | M12 SUS304 | 000-864-263 | 4 | |
| 8 | Seal Washer | CW1053DX | 000-850-021 | 4 | |
| 9 | Drain Tube | 03-003-3001-0 | 300-330-010 | 1 | |
| 10 | Safety Lanyard | 03-003-3002-0 | 300-330-020 | 1 | |
| 11 | Label (7) | 03-004-0207-0 | 300-402-070 | 1 | |





CHAPTER 1 OPERATION INSTRUCTIONS

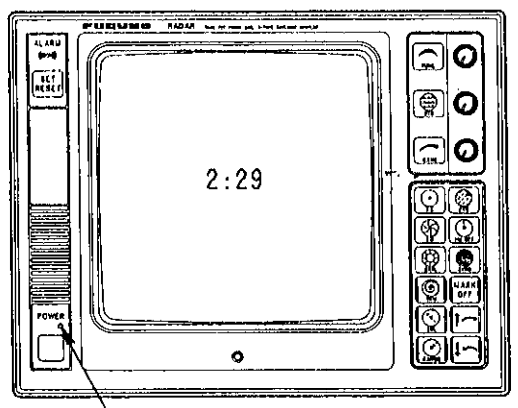
Adjustment and function for the respective operating controls are discussed in this chapter. Operating personnel should familiarize themselves with all the operating controls in order to make the best possible use of the equipment.

1.1 Function of Each Control (Refer to page 1-13.)

POWER Button

When this button is pressed, power is applied to all circuits of the radar system. Both the "ON" LED above the power button and the touchpad panel will light up, and the antenna will begin to rotate. To cut off power to the radar, press the button again.

Shortly after the radar set is turned on, the screen will read as shown in Fig.1-1 and the standby timer will begin to count down from 2min. 30 sec. When it reaches "0:01" the screen will display ST-BY, signifying the radar is ready for operation. Press the TX touchpad to begin transmission. The GAIN and TUNE controls should be adjusted to display the radar picture.




Power "ON" LED

Fig.1-1

After 2 min. 30 sec.

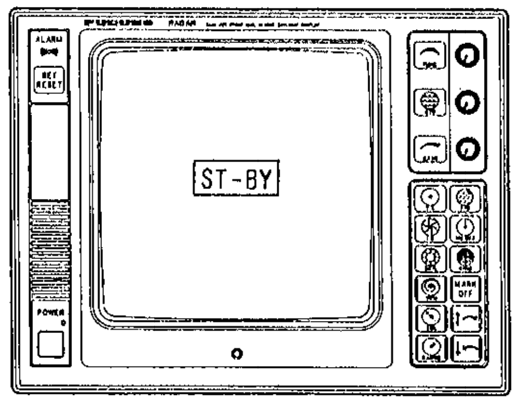



Fig.1-2

The following three controls are grouped together because they control the radar receiver. To prevent accidental alteration of the settings, all controls in this group may be locked by pushing in the control. When readjustment is necessary, push in and release the control to bring it out again.

TUNE Control

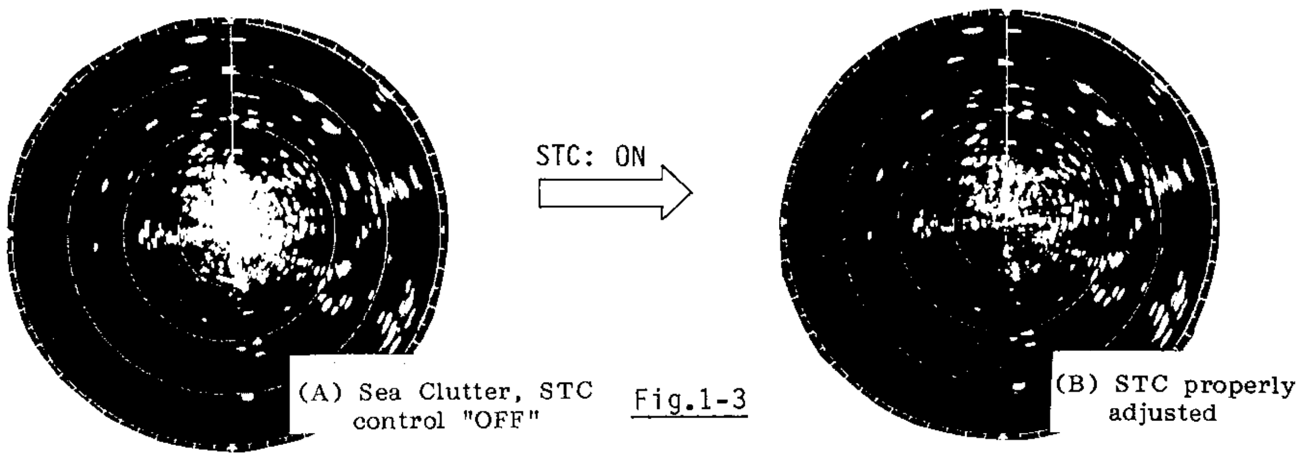
After the radar is set to transmit, this control is used to tune the receiver to the exact frequency of the transmitter. The tuning is made by moving the control slowly through the limits of its travel to find the position where a comparatively weak long range echo is discerned on the screen with maximum definition. The best tuning position is usually found at a point where the control is advanced 50% of its travel.

GAIN Control

This control adjusts the sensitivity of the receiver. When the control is turned clockwise the sensitivity of the receiver is raised, and the echoes of targets are displayed on the screen. If the radar is set on one of the longer ranges, the radar is adjusted properly when the speckled background on the screen just fades out. On short ranges, it is recommended that the GAIN control be set almost fully clockwise and the STC control be used to adjust the sensitivity.

STC Control

This control reduces the gain at close ranges, in order to suppress reflections from waves near own ship. When the control is turned clockwise, the sensitivity is reduced at close ranges (where sea clutter is the greatest) and the strength of echoes on greater ranges is restored gradually. The control is adjusted so that targets masked by the clutter remain on the screen; only the clutter is removed. If the control is turned too far to the right, the echoes from desired targets may be lost. Therefore adjust the control prudently. Set the control to the fully counterclockwise position when no clutter is visible on the screen.




(A) Sea Clutter, STC control "OFF"

Fig.1-3

(B) STC properly adjusted





The following are the functions of each touchpad.

TX Touchpad

Press this touchpad to alternate between transmit and ST-BY modes. After standby is completed, press the touchpad to begin transmitting.

After the radar is set to transmit the GAIN and TUNE controls are adjusted to display the radar picture. When the radar will not be used for an extended period of time, press the TX touchpad to set the radar to ST-BY. The message "ST-BY" will appear at the middle of the screen.

BRIL Touchpad

This touchpad changes the brightness of the CRT in 4 steps. Every depression of the touchpad changes the brightness stepwise.

RANGE & ARROW ↑ / ↓ Touchpads

The range selected automatically determines the fixed range ring interval, the number of fixed range rings and transmission pulselength, for optimal detection in both short and long ranges (see the Specifications). To select a range, press the RANGE touchpad, followed by pressing either the ↑ / ↓ touchpad, depending on whether you want to select a higher range or a lower range respectively. The range in use and corresponding fixed range ring interval are displayed at the top left-hand corner of the screen.

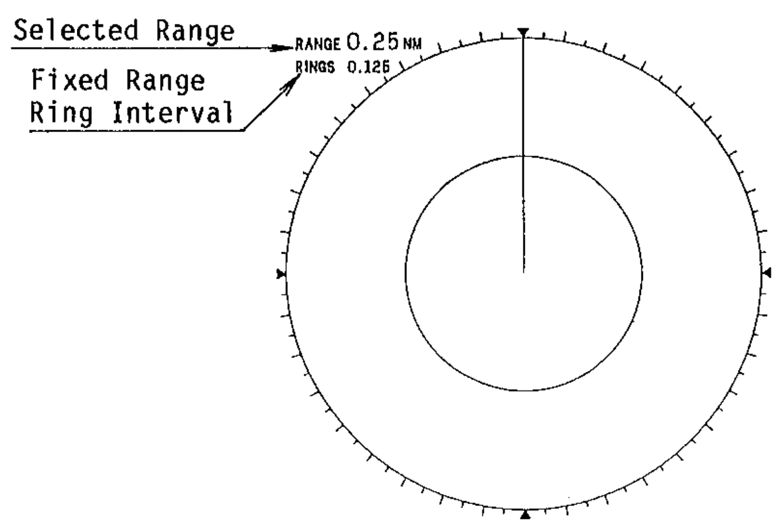
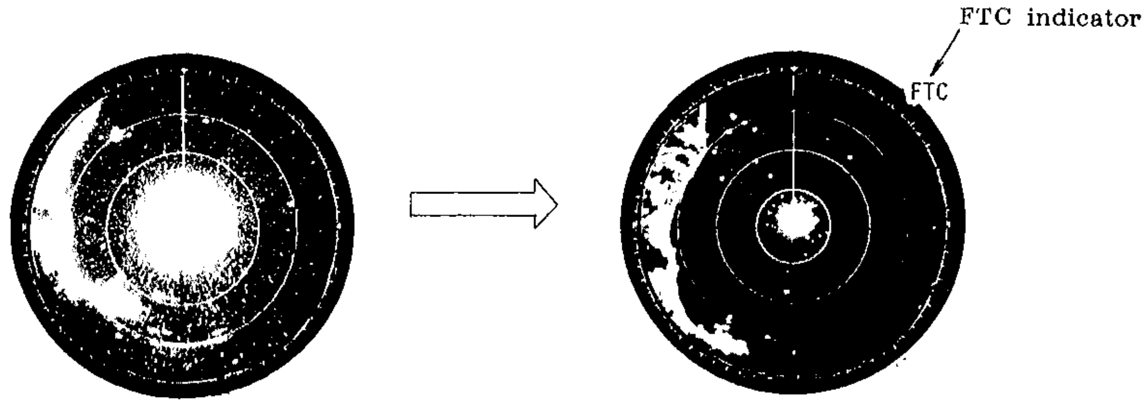



Fig.1-4

FTC (on/off) Touchpad

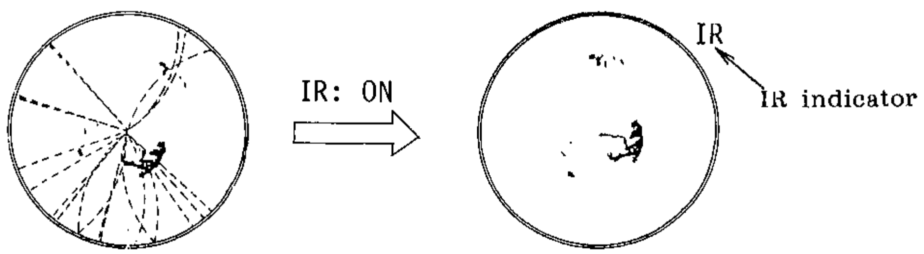
Echoes of ships operating inside rain, snow or hail storms may be hidden by the clutter displayed on the screen. When heavy storms or partial clutter is visible on the screen, press this touchpad to remove the clutter. Furthermore, when this touchpad is pressed in clear weather, it may be used to separate groups of echoes on a congested short range picture. If the FTC is activated, the letters "FTC" are displayed at the top right-hand side of the screen. To cancel the FTC function at any time, press the FTC touchpad again.




FTC: OFF    Fig.1-5    FTC: ON

IR (on/off) Touchpad

Should radar interference from other radars operating in the vicinity be observed on the screen (see Fig.1-6) this touchpad may be pressed to eliminate or suppress the interference. The interference rejector circuit is switched on whenever power is applied. Therefore deactivate the circuit when there is no interference. The letters "IR" appear at the top right-hand side of the screen when the circuit is activated.




Interference Rejector: OFF    Interference Rejector: ON

Fig.1-6

HM OFF Touchpad

Should you desire to observe a small echo under the ship's heading mark, press and hold this touchpad to erase the mark from the screen.



FURUNO

RING (on/off) Touchpad

The RING touchpad is pressed to turn on/off the fixed range rings. The fixed range rings are presented on the screen everytime the power is turned on. Therefore, press the touchpad to erase the rings from the screen when they are not needed.

As noted earlier the number and interval of the rings are related to the range in use. See the Specifications. The interval is displayed below the range in use at the top left-hand corner of the screen. See Fig.1-7.

VRM & ARROW / Touchpads

The VRM touchpad is pressed to display the VRM and its range indicator at the lower right-hand side of the screen. Then, press either the / touchpad to increase or decrease the range of the VRM respectively.

EBL & ARROW / Touchpads

The EBL touchpad is pressed to display the EBL and its bearing indicator at the lower left-hand side of the screen. Then, press either the / touchpad to rotate the EBL clockwise or counterclockwise respectively.

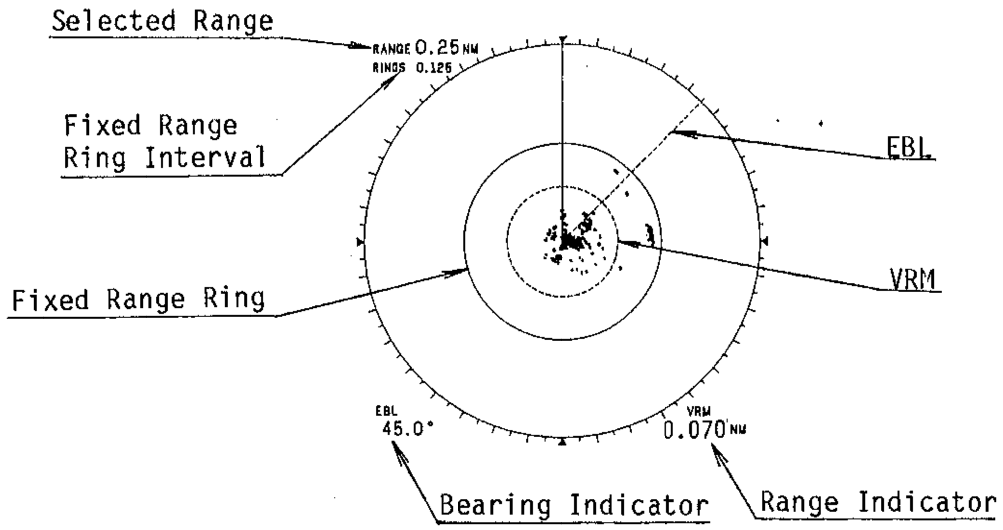
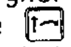



Fig.1-7

## ARROW Touchpad (used with VRM/EBL/RANGE)  / 

The two arrow touchpads are tri-colored to signify that they are used in conjunction with the EBL, VRM or RANGE touchpad. When activated by pressing one of the above three touchpads, the arrow touchpads are used to maneuver the markers which are used to measure the bearing and range of a target appearing on the display screen (EBL and VRM respectively), or change the range scale in use, depending on which touchpad is pressed. The  touchpad is used to rotate the EBL clockwise, or move the VRM out away from the center of the CRT, or select a higher range scale. The  touchpad performs the same function as the  touchpad except that it works in the opposite direction, e.g., it rotates the EBL counterclockwise, moves the VRM closer to the center, or selects a lower range scale. For operator convenience, a green light frames the on-screen indicator of the touchpad last pressed, among EBL, VRM and RANGE. This permits quick recognition of which setting can be changed without having to press the touchpad.

## MARK OFF Touchpad [MARK OFF]

The MARK OFF touchpad is colored green and orange to indicate that it is used in conjunction with the EBL and VRM touchpads. Its function is to erase the EBL and/or VRM from the screen.

## ALARM SET/RESET Touchpad [SET RESET]

The alarm is set by maneuvering the EBL and VRM to the desired guard zone followed by pressing the SET/RESET touchpad once. The message "ALARM" is displayed at the top right-hand side of the screen to alert the operator that the alarm is activated. Press and hold the SET/RESET touchpad for at least two seconds to cancel the alarm.

After the alarm is set the EBL and VRM may be operated without disturbing the settings of the alarm. Note that it is possible to set the range alarm only. The bearing sector alarm can not be set without first setting the range alarm. For further details about how the alarm is set, see page 1-10.

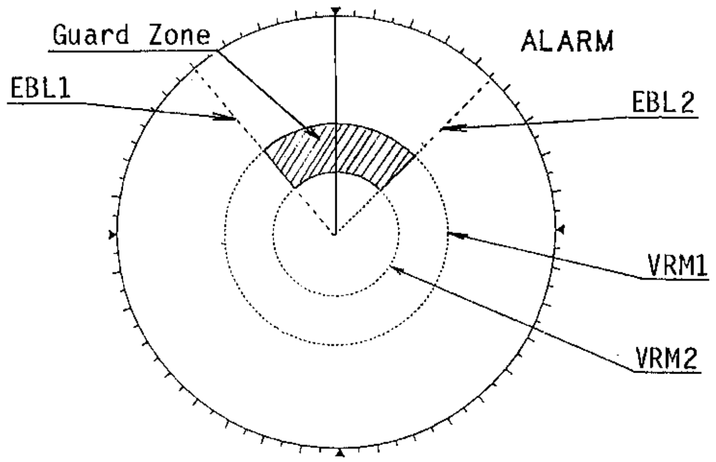



Fig.1-8





## 1.2 Operation Procedure

Confirm that the following points are satisfied before turning on the radar.

1) Confirm that the power supply is within the rating.
2) Check that the settings of the controls are as shown below.

| Button & Controls | Settings |
|---|---|
| POWER | OFF |
| GAIN & STC | Fully CCW |
| TUNE | Center |
| Others | Any positions |

| Starting | Remarks |
|---|---|
| Press POWER button. | Power is supplied to radar, the antenna begins to rotate and time remaining for warm-up is displayed. See Fig.1-1. |
| ↓ Wait for 2min. 30sec. | Indication of "ST-BY" is displayed, showing that radar is ready to transmit. See Fig.1-2. |
| ↓ Press TX touchpad. | Transmission begins on 0.25 n.m. range and range rings are observed on the screen. |
| ↓ Adjust GAIN control. | Target echoes appear. |
| ↓ Set the detecting range at maximum by pressing RANGE &  touchpads and adjust TUNE control. | Adjustment of TUNE control should be made 10 minutes after transmission has begun. Adjust the control so that a comparatively weak long range echo is discerned on the screen with maximum definition. The tuning point is normally found around mid-travel. |
| ↓ Select the desired range. | |
| ↓ Adjust GAIN/STC controls and FTC touchpad according to weather/sea conditions. | |

Continued

To measure range to a target, use VRM or fixed range rings. -------- See para. 1-3.

To measure the bearing of a target, use the EBL. ---- See para. 1-4 on page 1-9.

Set guard zone, if desired. ----------- See para. 1-5 on page 1-10.

Press TX touchpad to cease radar operation temporarily. ---- To extend the life of the magnetron it is recommended to set the radar to ST-BY unless observation of the picture is necessary.

Stopping

Ensure the GAIN control is turned fully counterclockwise before turning off the power.

## 1.3 Range Measurement

1) Range Measurement with the Fixed Range Rings

The range to a target is measured roughly with the fixed range rings. The rings are displayed on the screen by pressing the RING touchpad. To measure the range to a target, first check the range ring interval, shown at the upper left-hand corner of the screen. Then count the number of rings between the center of the CRT and the target, and estimate the range to the target.

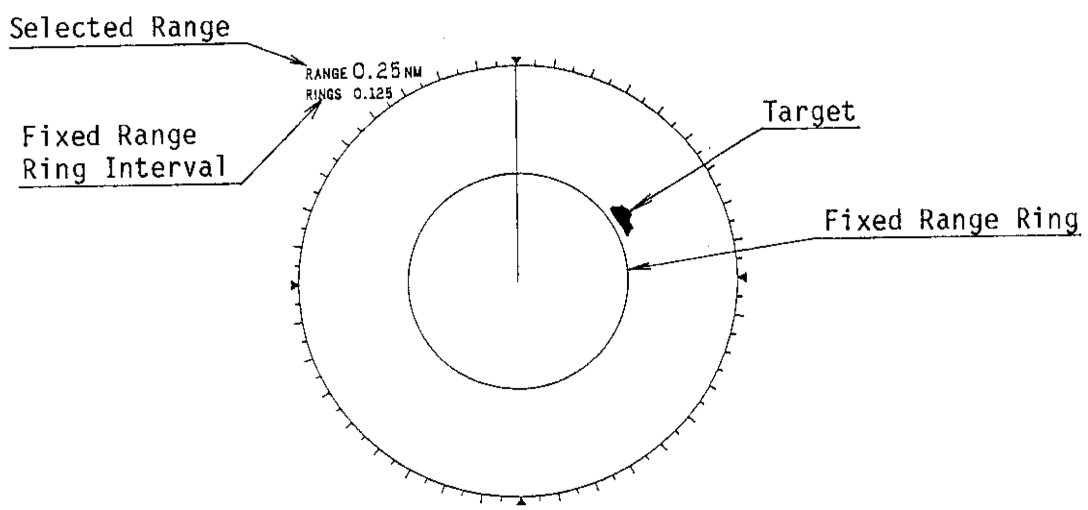



Fig.1-9





2) Range Measurement with the VRM

The range to targets can measured more accurately using the VRM.

1. Press the VRM touchpad to display the VRM on the screen.
2. Press [↑] or [↓] touchpad until the circle described by the VRM touches the inside edge of the target.
3. The range measured by the VRM can be read at the lower right-hand corner of the screen.

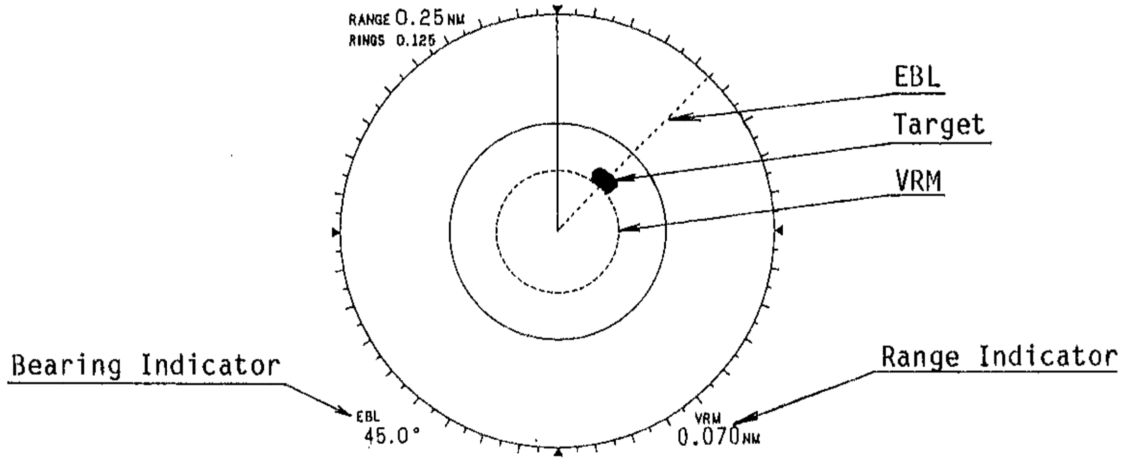



Fig.1-10

## 1.4 Bearing Measurement

1. Press the EBL touchpad to display the EBL on the screen.
2. Press [↑] or [↓] touchpad until the EBL is positioned over the center of the target.
3. The bearing measured by the EBL can be read at the lower left-hand corner of the screen. (The bearing measured is relative to own ship.)

## 1.5 Radar Alarm Setting

The alarm function allows the operator to set the desired range (0 to maximum range) and bearing (0 to 360°) for a guard zone. Should ship's, islands, landmasses, etc. come into the guard zone an alarm will be generated. The alarm is very effective as an anti-collision aid when using an autopilot or navigating in narrow channels.

Although the alarm is useful as anti-collision aid, it does not relieve the operator of the responsibility to watch out for possible collision situations. The alarm should not be used as a primary means to detect possible collision situations.

Now the procedure to set the alarms.

Procedure

Before setting the alarm ensure the gain is set properly. Too high a gain will trip the alarm needlessly, and if the gain is set too low weaker targets may be missed; the alarm will not sound should weaker targets come into the guard zone. To set, for example, a guard zone between 2.20 and 3.30nm use the following procedure.

1. Set the range at 4nm; press the VRM touchpad to display the VRM marker on the screen. VRM1 is displayed at the top right-hand side of the screen.

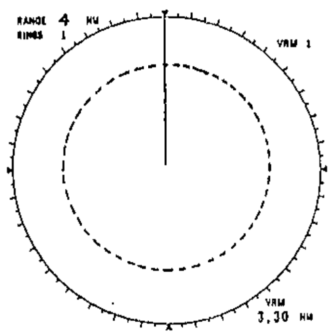


Fig.1-11

2. While observing the VRM indicator at the lower right-hand side of the screen, press [▢] / [▢] until the VRM stops at 3.30nm. (The order which you set the inner and outer range limits is interchangeable.) See Fig.1-11.

3. Press the SET/RESET touchpad once, and the outer/inner range of the alarm is set. At this time a weak intensity ring is overlaid on the VRM to mark the inner or outer limit of the guard zone. Furthermore, the message "VRM1" will change to "VRM2," and the message "ALARM" is displayed at the top right-hand side of the screen, indicating the alarm is now activated. See Fig.1-12.

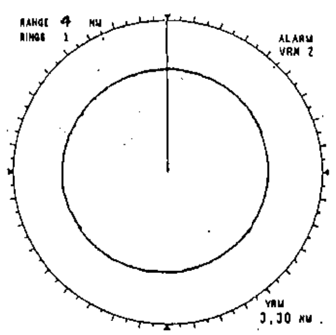


Fig.1-12





4. Press [▢] / [▢] until the VRM stops at 2.20nm (depending on which one was set in step 2) and press the SET/RESET touchpad. A "doughnut ring" marks the inner and outer limits of the alarm. See Fig.1-13 and Fig.1-14.

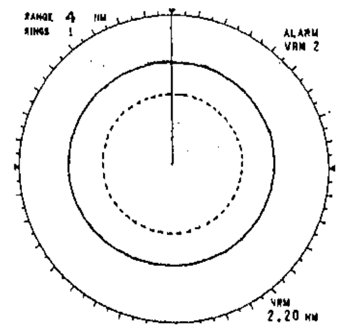


Fig.1-13

5. To change the inner or outer range of the alarm, repeat steps 2 thru 4. Now if a target comes into the zone marked by the doughnut ring an alarm is sounded. You may cancel the alarm at any time by pressing and holding the SET/RESET touchpad for at least two seconds. If the guard zone goes out of the screen when changing to a lower range, the message "UP RANGE" is displayed at the top right-hand side of the screen, informing you to up the range to redisplay the guard zone on the screen.

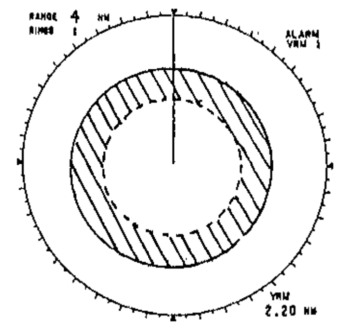


Fig.1-14

If you desire to set a bearing sector alarm as well, proceed to the next step.

To set, for example, a 90° bearing sector between 315° and 45°, use the following procedure.

6. Press the EBL touchpad to display the EBL on the screen. EBL1 is displayed at the top right-hand side of the screen.

7. By observing the EBL indicator at the lower left-hand side of the screen, press the [▢] / [▢] touchpad until the EBL is positioned at 315°. See Fig.1-15.

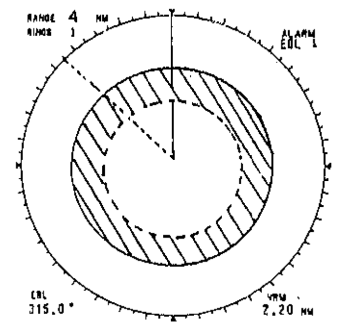


Fig.1-15

8. Press the SET/RESET touchpad, and the bearing in step 7 is set. A small 2-3 degree blank space is created in the doughnut ring at the area around 315°, however it is "repainted" once the other side of the bearing sector is set. At this time the EBL1 indication will change to EBL2, indicating you should set the other side of the bearing sector. See Fig.1-16.

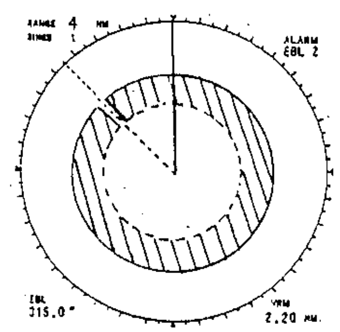


Fig.1-16

9. Then, press [↑] / [↓] to position the EBL at 45°, and hit the SET/RESET touchpad. The setting of the guard zone is now completed. To change the bearing sector, repeat steps 7 and 8. See Fig.1-17 and Fig.1-18.

10. Any ships, islands, landmasses, etc. coming into the guard zone will trigger the alarm, telling the operator to proceed with caution. The guard zone and alarm sound may be cancelled at any time by pressing and holding the SET/RESET touchpad for at least two seconds.

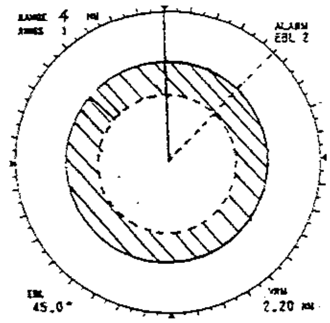



Fig.1-17

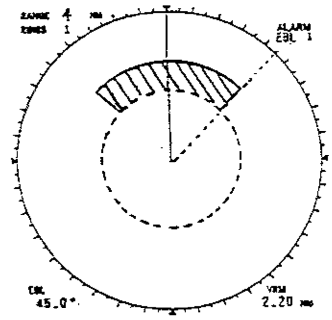
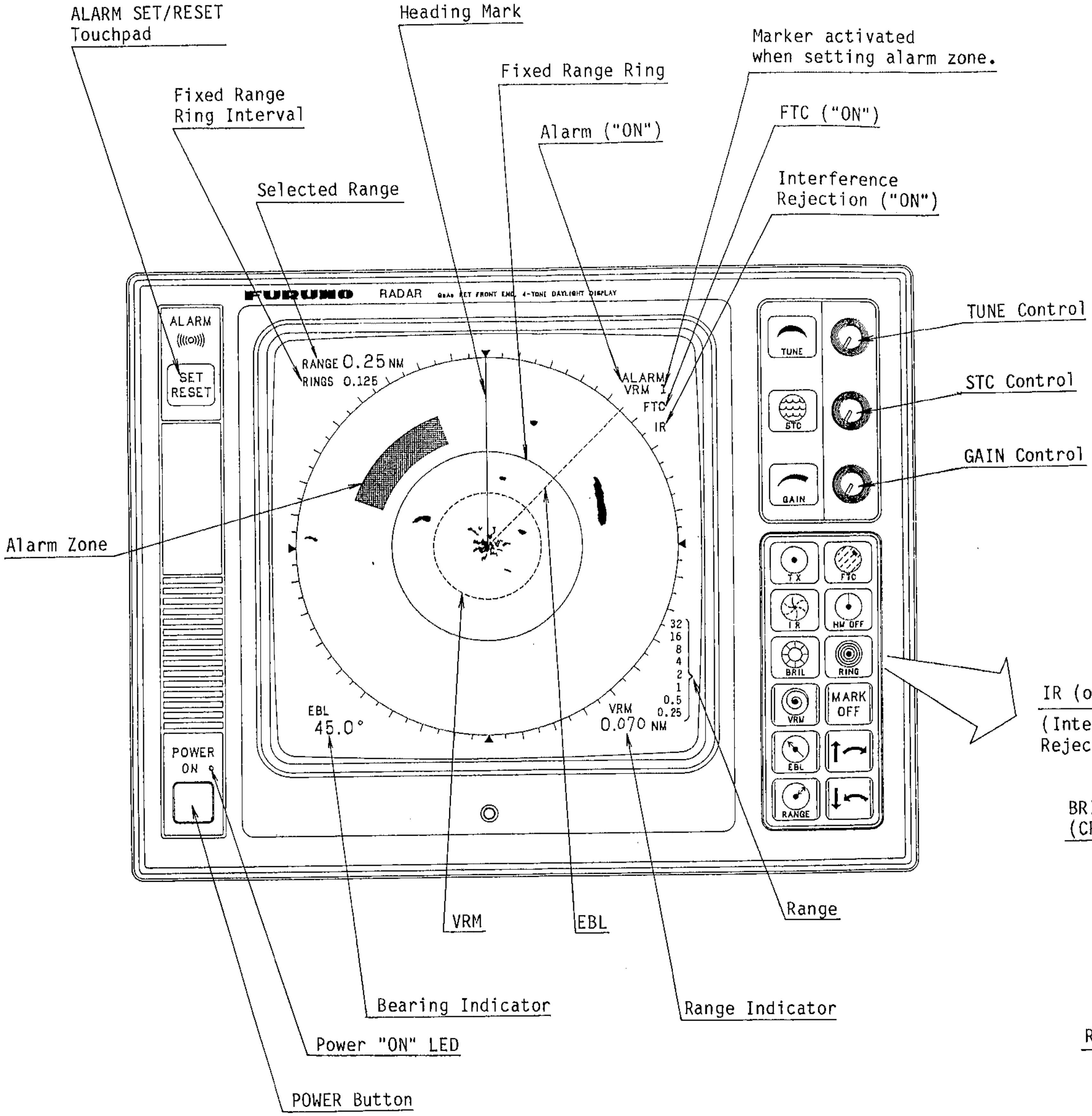
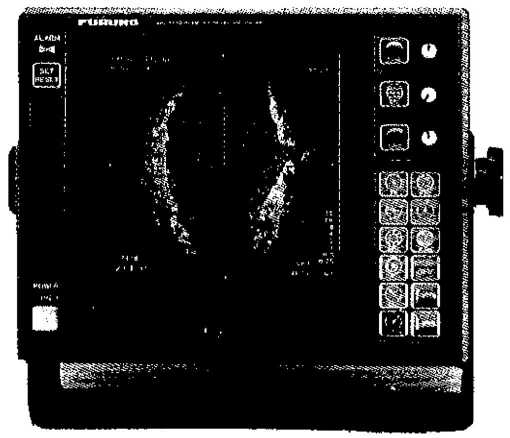
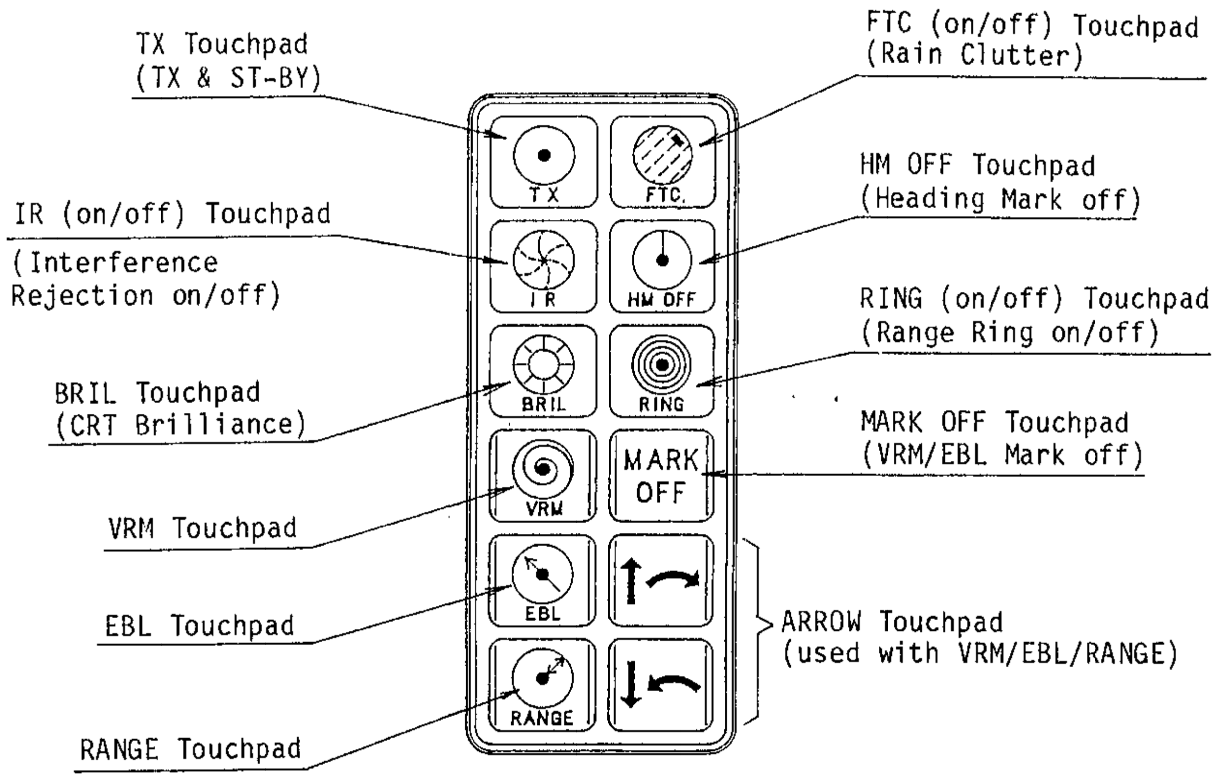



Fig.1-18



N Photo No.2144 PC




(Touchpad Panel)

# CHAPTER 2 REMARKS ON VIEWING PICTURE

## 2.1 Minimum and Maximum Ranges

Maximum range

The maximum detecting range of the radar, Rmax, varies considerably depending upon several factors such as the height of the antenna above the sea, the height of the target above the sea, the size, shape and material of the target, and the atmospheric conditions.

Under normal atmospheric conditions, the maximum range is equal to the radar horizon or a little shorter. The radar horizon is longer than the optical one by about 6% because of the diffraction property of the radar signal. The Rmax is given in the following equation.

$$R_{max} = 2.2 \times (\sqrt{h1} + \sqrt{h2})$$

where Rmax: Radar horizon (n. mile)
h1 : Antenna height (meter)
h2 : Target height (meter)

For example, if the height of the antenna above the sea is 9 meters and the target height is 16 meters, the maximum radar range is;

$$R_{max} = 2.2 \times (\sqrt{9} + \sqrt{16}) = 2.2 \times (3 + 4) = 15.4 \text{ (n. miles)}$$

Minimum Range

When the radar is used as a collision avoidance aid the minimum range is of urgent concern. It is very dangerous for a target to disappear when it approaches the ship. The minimum range is determined by the transmission pulse width and the height of the antenna (vertical beam width of antenna) above the sea.

## 2.2 Radar Resolution

Bearing Resolution

Bearing resolution is the ability to discriminate two targets which are located at the same range and close to each other. It is proportional to the length of the antenna and reciprocally proportional to the wave length. The usual bearing resolution is 1 to 3 degrees.



FURUNO

Range Discrimination

Range discrimination is the ability to distinguish two targets which are in the same direction and close to each other. This is determined by pulselength only. The average discrimination range is 25 yards on a 0.08 micro-second pulse.

## 2.3 Bearing Accuracy

One of the most important features of the radar is how accurately the bearing of the target can be measured. The accuracy of the bearing measurement basically depends on the narrowness of the radar beam. However, the bearing is usually taken relative to the ship's heading, and thus, the adjustment of the heading marker at installation is an important factor to determine bearing accuracy. To minimize error when measuring the bearing of a target, put the target echo at the extreme position on the screen by selecting a suitable range.

## 2.4 Range Measurement

Measurement of the range to a target is also a very important function of the radar. Generally, there are two means of measuring the range: the fixed range rings which appear on the screen with a predetermined interval as a reference of the range measurement, and the variable range marker which can be moved inwards and outwards so that it will touch the inside edge of the target. The range to the target measured by the VRM is displayed digitally.

## 2.5 False Echoes

Occasionally echo signals appear on the screen at positions where there is no target or disappear even if there are targets. They are, however, recognized if you understand the reason why they are presented. Typical false echoes are shown below.

Multiple Reflection

When a wide and plane target such as the sideboard of a ship, bridge, building on a pier and breakwater exists near the ship, radar pulses are multi-reflected between your ship and the target. This results in presentation of multiple echoes on the screen. The multiple echoes appear at equal intervals after the true echo as shown in Fig.2-1.

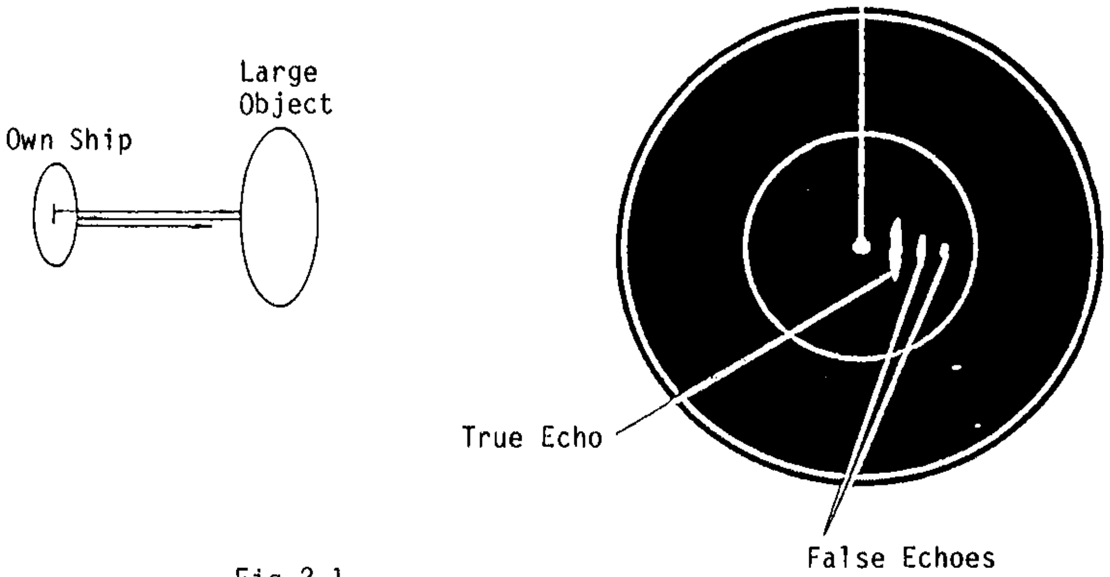



Fig.2-1

## Spurious Echoes

When the radar pulse is emitted from the antenna radiator, some of the total emitted energy escapes on each side of the main beam--sidelobes. If the target is strong, it can be detected by the sidelobes as well as the main lobe, the spurious echoes may be represented at both sides of the true echo with the same range as shown in Fig.2-2. Spurious echoes can be removed by adjusting the GAIN and STC controls.

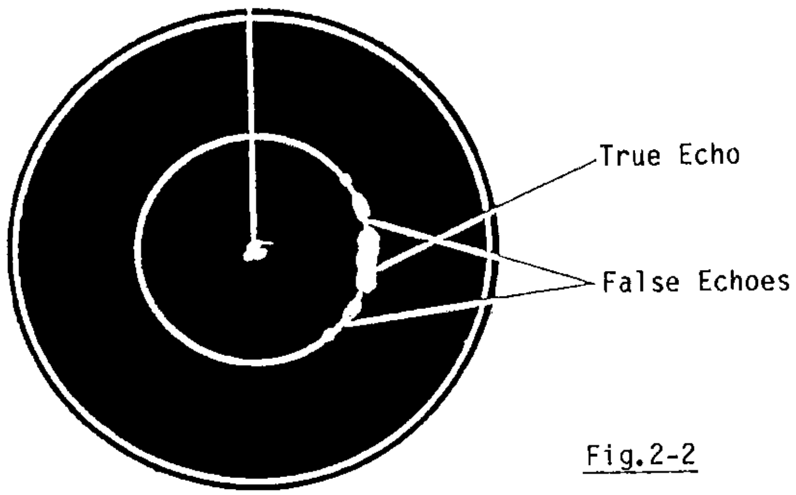



Fig.2-2

## Second-trace Echoes

If radio wave propagation is extraordinary, echoes from very distant targets may appear on the screen. In this case, they may return after the echoes from the next transmission pulse have appeared. Thus false echoes appear together with the true echoes of the near distant targets.





## Virtual Image

A relatively large target close to your ship may be represented at two positions on the screen. One of them is the true echo directly reflected by the target and the other is a false echo which is caused by the mirror effect of a large object on or close to your ship as shown in Fig.2-3. If, for example, your ship comes close to a large steel bridge such a false echo may temporarily be seen on the scope.

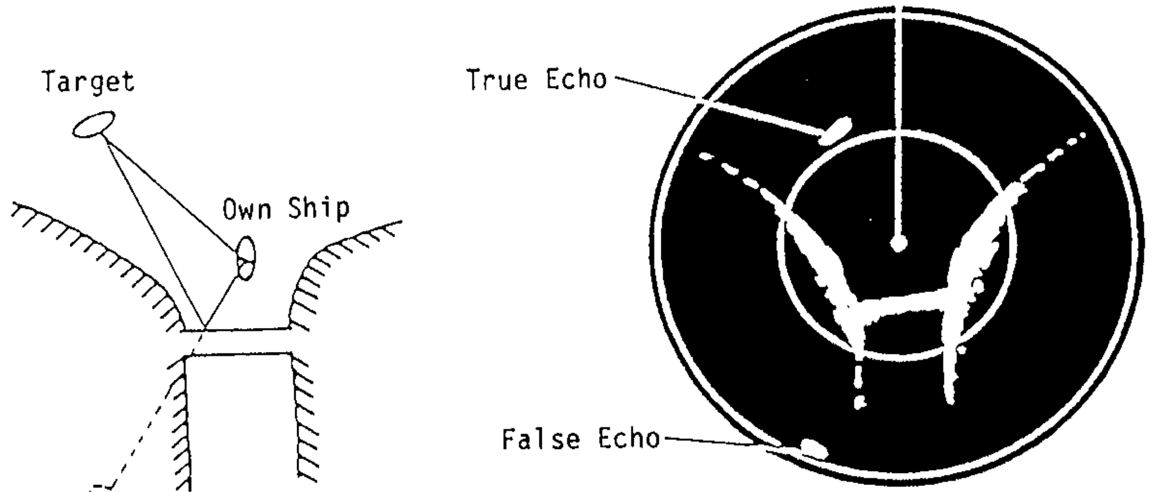



Fig.2-3

## Dead Angle (Blind Sector)

A funnel, mast or derrick post near the radar antenna may intercept the radar beam. In that case, no target is detected within a certain angle--called a "dead angle." A large object close to your ship may produce a similar effect.

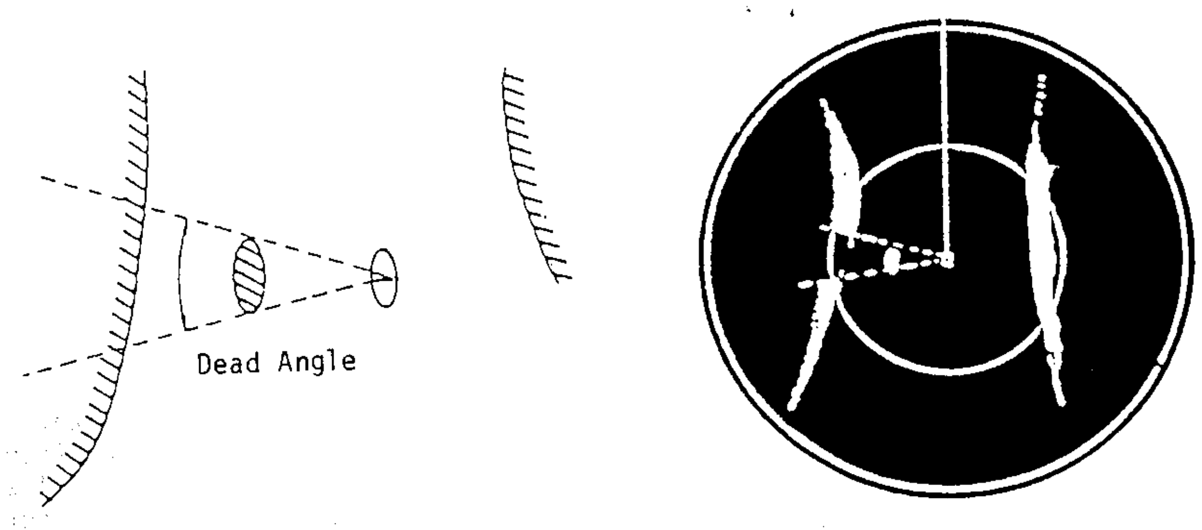



Fig.2-4

Radar Interference

When another ship is operating a radar the same frequency as your own ship's radar, the radar pulses emitted from the other ship are received and appear on your radar screen as the curved spokes shown in Fig.2-5.

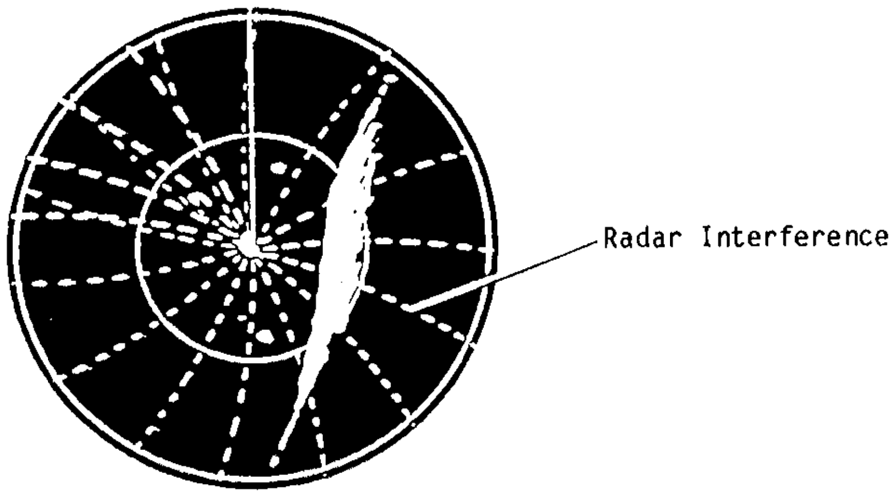



Fig.2-5





CHAPTER 3 MAINTENANCE

To maintain optimum performance of the equipment for an extended period, general check and maintenance should be made periodically.

"CAUTION"

Before maintenance work, be sure to switch off the radar at the main switchboard. When checking inside the units, wait for a few minutes until the high voltage components (CRT or HV capacitors) can discharge the residual charge.

| Interval | Item | Check/Measures | Remarks |
|---|---|---|---|
| 3 to 6 months | Exposed bolts and nuts on scanner unit | Check for corroded or loosened bolts/nuts. If necessary, clean them and repaint thickly. Replace them with new ones if heavily corroded. | *Sealing compound may be used instead of paint. *Put slight amount of grease if bolts and nuts are replaced. |
| | Radome | Check for dirt or cracks on the radome surface. Thick dirt should be wiped off by using a soft cloth immersed in fresh water. If any crack is found, apply a slight amount of sealing compound or adhesive as first-aid treatment, then call for repair. | *Do NOT use plastic solvent (thinners or acetone) for cleaning. |
| | Plugs in the scanner unit (See Fig.3-1.) | Open upper radome cover to check plug connections inside. Also check if the rubber packing of the radome cover is in good order. | *When putting cover back in position, do not pinch flying wires. |
| | CRT screen | Dirt on this creates symptom identical to poor sensitivity. Clean CRT surface using special care not to scratch it. | *Use a soft cloth with a slight amount of anti-static-charge spray. Never apply plastic solvent. |

Continued

| Interval | Item | Check/Measures | Remarks |
|---|---|---|---|
| 6 months to 1 year | CRT anode (See Fig.3-2.) | High tension on CRT attracts dust in environment, and moist dust will cause poor insulation. | *If rubber cap is abnormally dusty or if any cracks are found on rubber cap or wire sheath, call for service. Do not try to clean or repair it for yourself, because these components are extremely delicate and high voltage may exist. |
| | Terminal boards, sockets and plugs | Check for loose connections. Clean contacts or replace plug, if necessary. | |

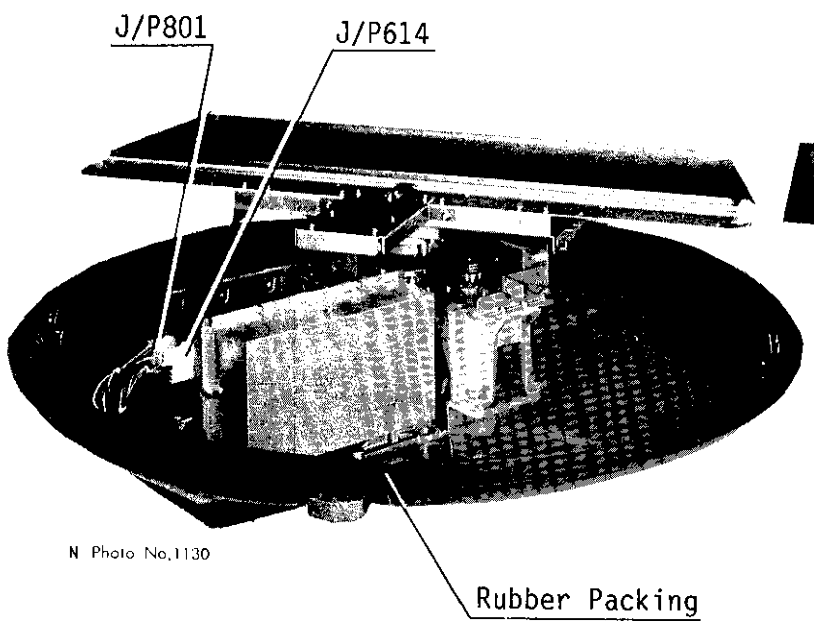



Fig.3-1 Scanner Unit

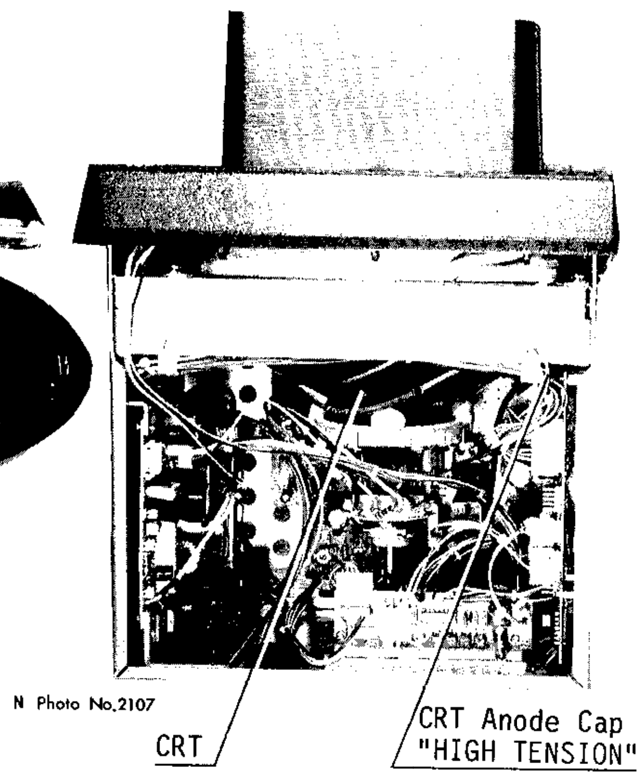



Fig.3-2 Top View of Display Unit





# CHAPTER 4 TROUBLESHOOTING

Whenever an unusual symptom is encountered, turn off the radar and check the plug connections on p.c. boards, then proceed to individual function check along with the Trouble Finding List on the next page. If some board is found to be faulty, replace it with a new one or call for service. Do not attempt further component check in the p.c. board. Careless handling may cause more serious trouble.

"CAUTION"

There are many high tension points in the radar system. Take special care when approaching the following parts.

1. Power supply circuit (Display Unit)
2. CRT circuit (Display Unit)
3. Modulator circuit (Scanner Unit)
4. Magnetron (Scanner Unit)

## Notes on Service Call

To obtain effective service, the following information should be given at a service call.

1. Name of the vessel
2. Vessel's position (port/berth)
3. Sailing Schedule
4. Radar model (Serial number/Date manufactured)
5. Symptom of trouble
   (Results of checks along with the Trouble Finding List)
6. Previous service

Trouble Finding List

| Operation | Symptom | Check Point | Remarks |
|---|---|---|---|
| Press POWER button. | Power is not applied to radar system. ("ON" LED above the POWER button does not light up.) | 1. Main fuse F1351 (Display rear) See Fig.4-1.<br>2. Mains voltage/ polarity<br>3. POWER SUPPLY board (PTU-6171) See Fig.4-2. | *Measure mains voltage at TP301 #2(+) - #1(-). See Fig.4-2. The voltage should be between 10.2 and 40.0VDC. |
| | Antenna does not rotate. | 1. Scanner rotating mechanism jammed<br>2. Power supply circuit for scanner motor<br>3. Plug P21 on display rear (Fig.4-1)<br>4. Scanner motor | *Remove inner panel on display rear (Fig.4-1) and check the connection of plug P21. If it is disconnected or loosened, connect it tightly. |
| | Nothing appears on CRT. | 1. CRT<br>2. CRT H.T. (Fig.4-2)<br>3. CRT board (Fig.4-2)<br>4. PROCESSOR board (Fig.4-3) | *Visually check that CRT heater is lit.<br>*Adjust CONTRAST pot.(R7) and BRIGHT pot.(R37) on CRT board (Fig.4-2). If some picture appears, CRT assembly is OK. |

Continued





| Operation | Symptom | Check Point | Remarks |
|---|---|---|---|
| | Picture synchronization is abnormal. | 1. CRT board<br>2. PROCESSOR board (Fig.4-3) | *Adjust vertical synchro pot.(L1) and horizontal synchro pot.(R56) on CRT board (Fig.4-2). If synchronization is not achieved, CRT board is defective. |
| After message ST-BY appears, press TX touchpad. | Marks and legends appear abnormally. | 1. PROCESSOR board (Fig.4-3) | |
| Adjust GAIN control with STC set at minimum. | Marks and Legends appear but no noise nor echo. | 1. IF amplifier<br>2. Multicore cable between display and scanner units<br>3. PROCESSOR board (Fig.4-3) | *Check continuity and isolation of coaxial cable. Note that coaxial cable should be disconnected at both ends before checking it with ohmmeter. |
| | Marks, legends and noise appear but no echo. (Transmission circuit may be faulty.) | 1. PROCESSOR board (Fig.4-3)<br>2. Multicore cable (TX trigger line) between display and scanner units<br>3. Magnetron<br>4. Modulator circuit | *Transmit the radar on maximum range and measure magnetron current, referring to Fig.4-4. If the voltage is not within the rated value mentioned in Fig.4-4, magnetron is deteriorated. |
| | Sweep rotation is not synchronized with antenna rotation. | 1. Bearing signal generator (Scanner unit)<br>2. PROCESSOR board (Fig.4-3) | |

Continued

| Operation | Symptom | Check Point | Remarks |
|---|---|---|---|
| Adjust TUNE control. | Poor sensitivity | 1. Deteriorated magnetron<br>2. Detuned MIC | *Transmit the radar on maximum range and measure magnetron current, referring to Fig.4-4. If the voltage is not within the rated value mentioned in Fig.4-4, magnetron is deteriorated. |
| | Poor sensitivity (Bright circle appears on 0.25 n.m. range.) | 1. Water leakage inside antenna | |
| Press each touchpad key | Function corresponding to the touchpad pressed is not activated. | 1. Bad contact of touchpad key<br>2. PROCESSOR board (Fig.4-3) | |
| Set radar alarm zone. | Alarm zone is not produced by pressing SET/RESET touchpad. (Message ALARM does not appear.) | 1. Bad contact of touchpad key<br>2. ATI board (Fig.4-2)<br>3. PROCESSOR board (Fig.4-3) | |
| | Alarm zone appears but no alarm sound. (Message ALARM appears on CRT.) | 1. Buzzer<br>2. ATI board (Fig.4-2) | |

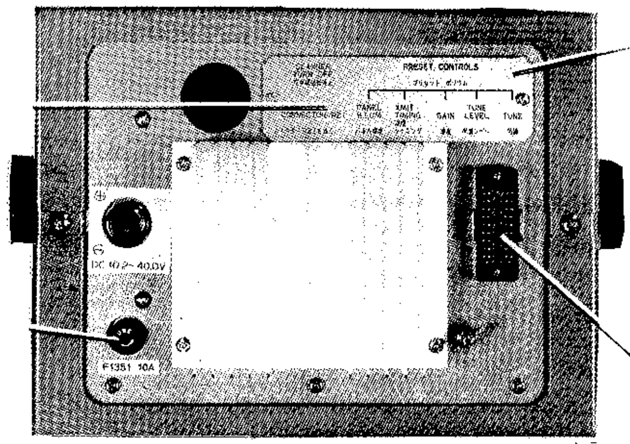



Fig.4-1 Display Unit, Rear View





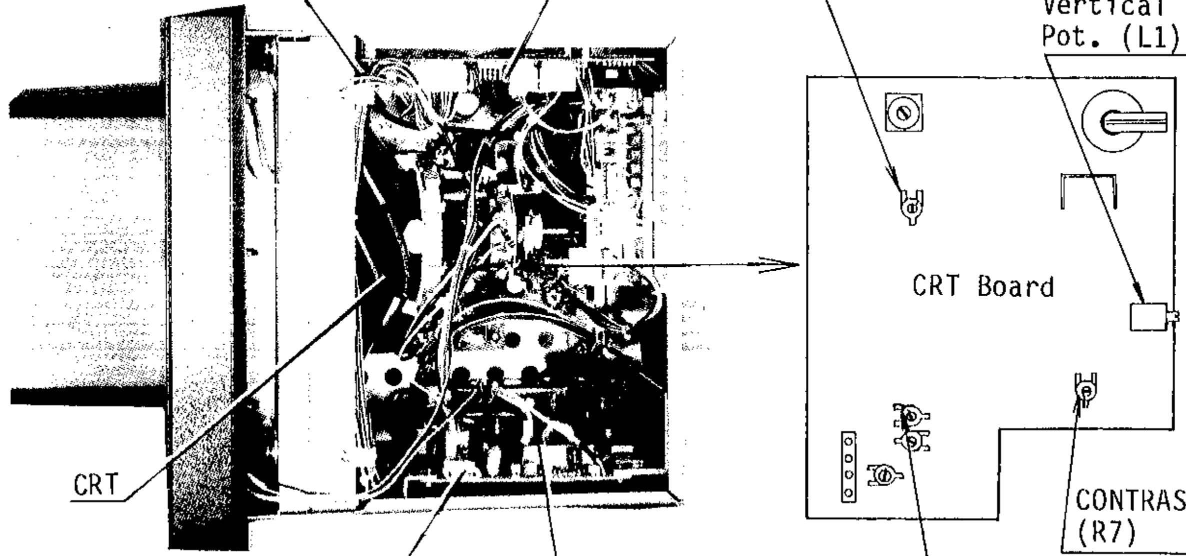



Fig.4-2 Display Unit, Top View (Cover removed)

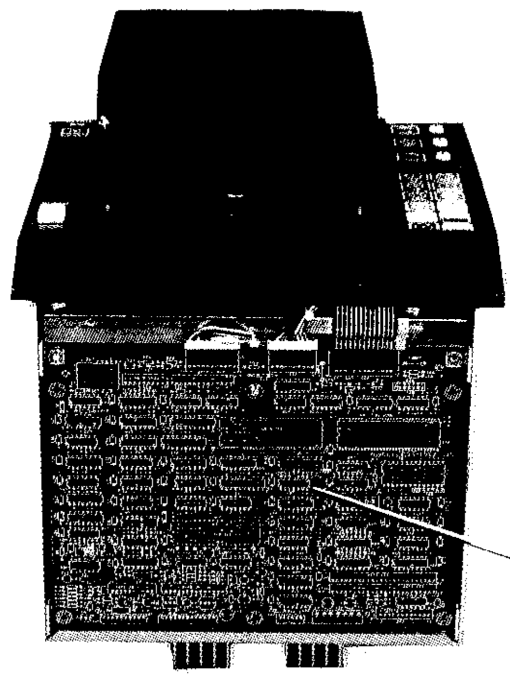
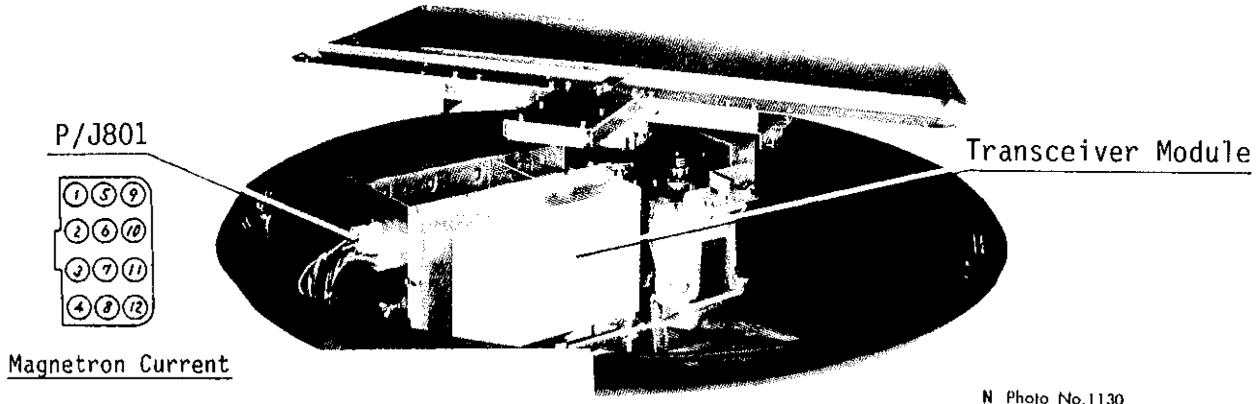



Fig.4-3 Display Unit




Check Point: P801 #3(+) - #5(-)
Rated Value: 1.3 to 2.4VDC (short ranges)
1.8 to 2.4VDC (long ranges)

Fig.4-4 Scanner Unit

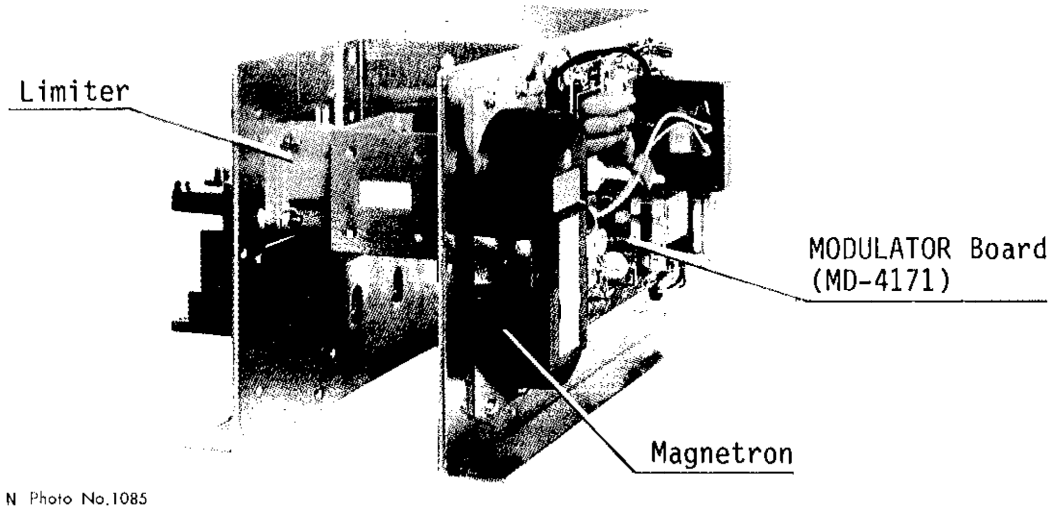



Fig.4-5 Transceiver Module

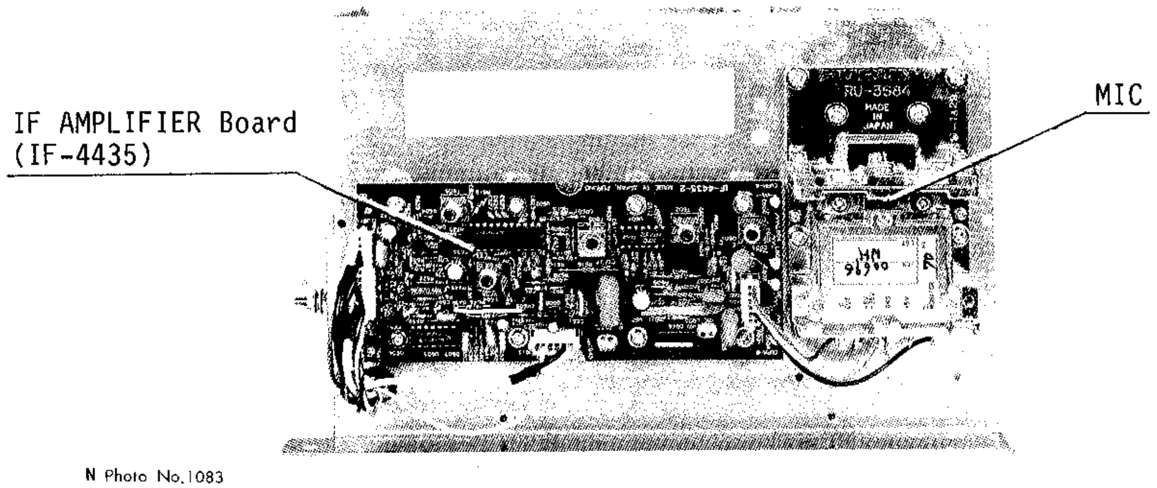



Fig.4-6 Transceiver Module

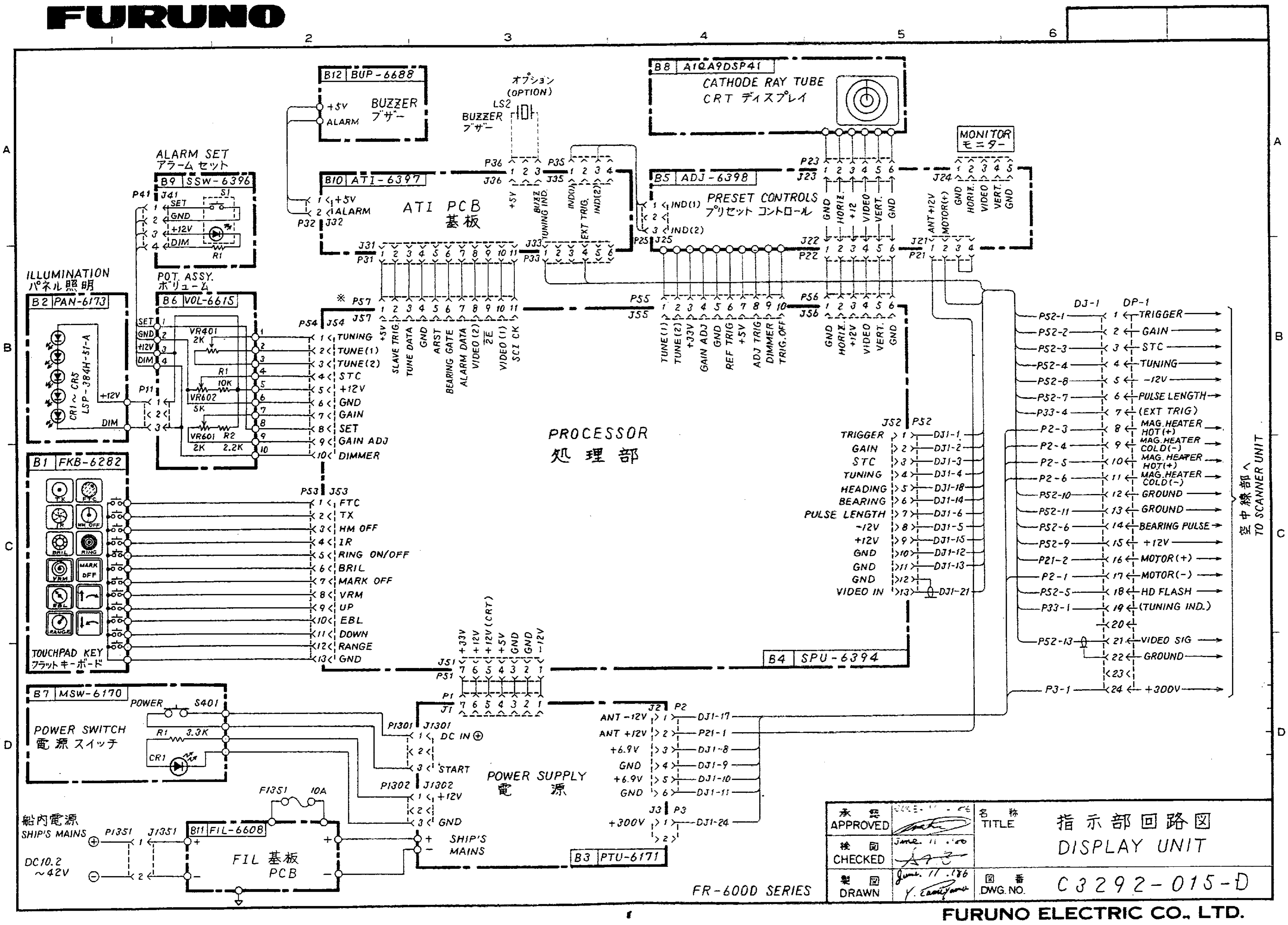




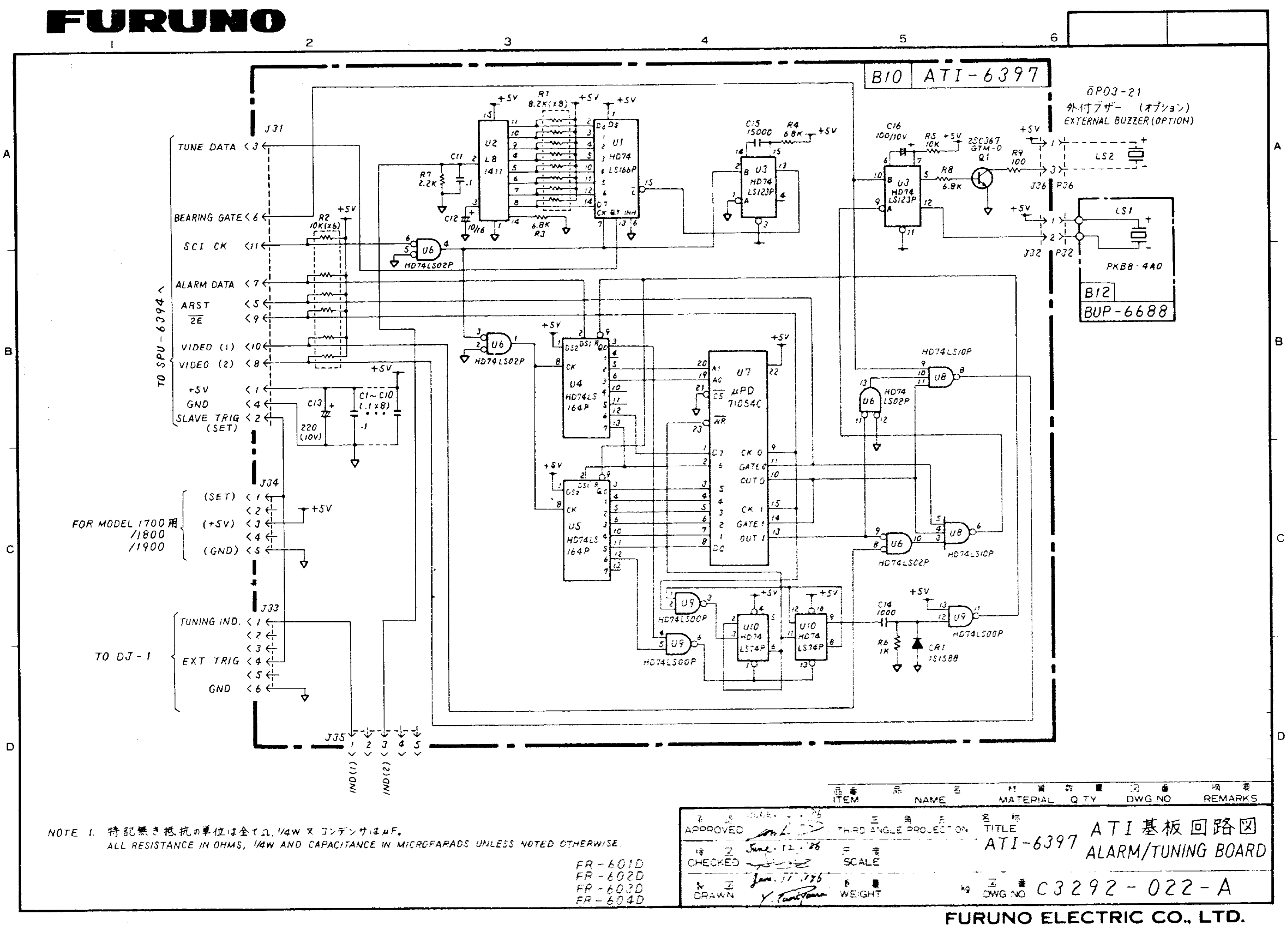
CONTENTS OF SCHEMATIC DIAGRAMS



CONTENTS OF OUTLINE DRAWINGS

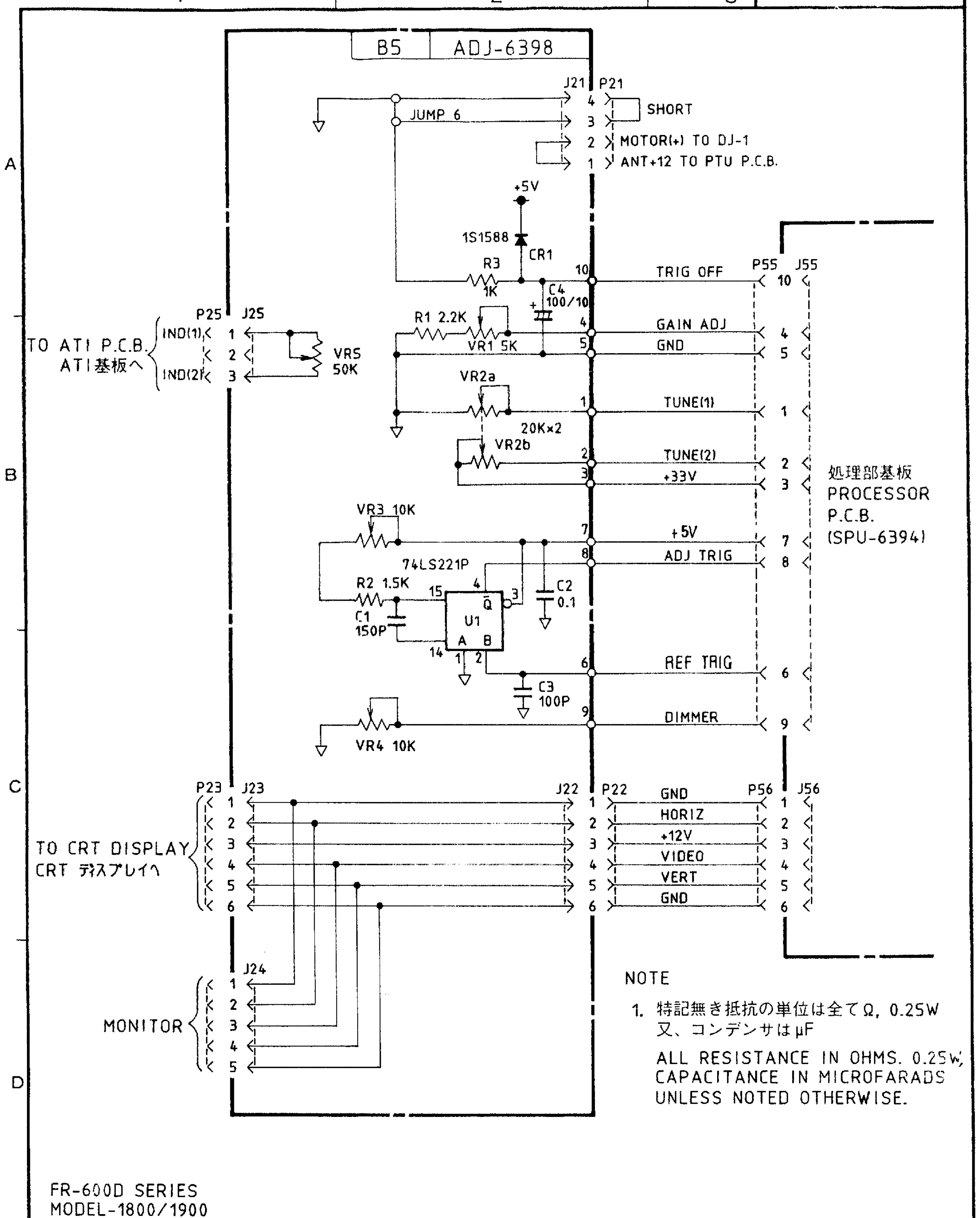

FURUNO
B12 BUP-6688
BUZZER ブザー
オプション (OPTION)
B8 A1QA9DSP41
CATHODE RAY TUBE
CRT ディスプレイ
MONITOR モニター
ALARM SET アラームセット
B9 SSW-6396
B10 ATI-6397
ATI PCB 基板
B5 ADJ-6398
PRESET CONTROLS プリセットコントロール
ILLUMINATION パネル照明
B2 PAN-6173
POT. ASSY. ボリューム
B6 VOL-6615
PROCESSOR 処理部
B1 FKB-6282
TOUCHPAD KEY フラットキーボード
B4 SPU-6394
B7 MSW-6170
POWER SWITCH 電源スイッチ
POWER SUPPLY 電源
船内電源 SHIP'S MAINS
DC10.2 ~42V
B11 FIL-6608
FIL 基板 PCB
B3 PTU-6171
空中線部へ TO SCANNER UNIT
FR-600D SERIES
指示部回路図
DISPLAY UNIT
C3292-015-D
FURUNO ELECTRIC CO., LTD.

S-1


FURUNO
B10 ATI-6397
TO SPU-6394
FOR MODEL 1700用 /1800 /1900
TO DJ-1
6P03-21
外付ブザー (オプション)
EXTERNAL BUZZER (OPTION)
B12 BUP-6688
NOTE 1. 特記無き抵抗の単位は全てΩ, 1/4W × コンデンサはμF.
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE
FR-601D
FR-602D
FR-603D
FR-604D
ATI基板回路図
ATI-6397 ALARM/TUNING BOARD
C3292-022-A
FURUNO ELECTRIC CO., LTD.

S-2

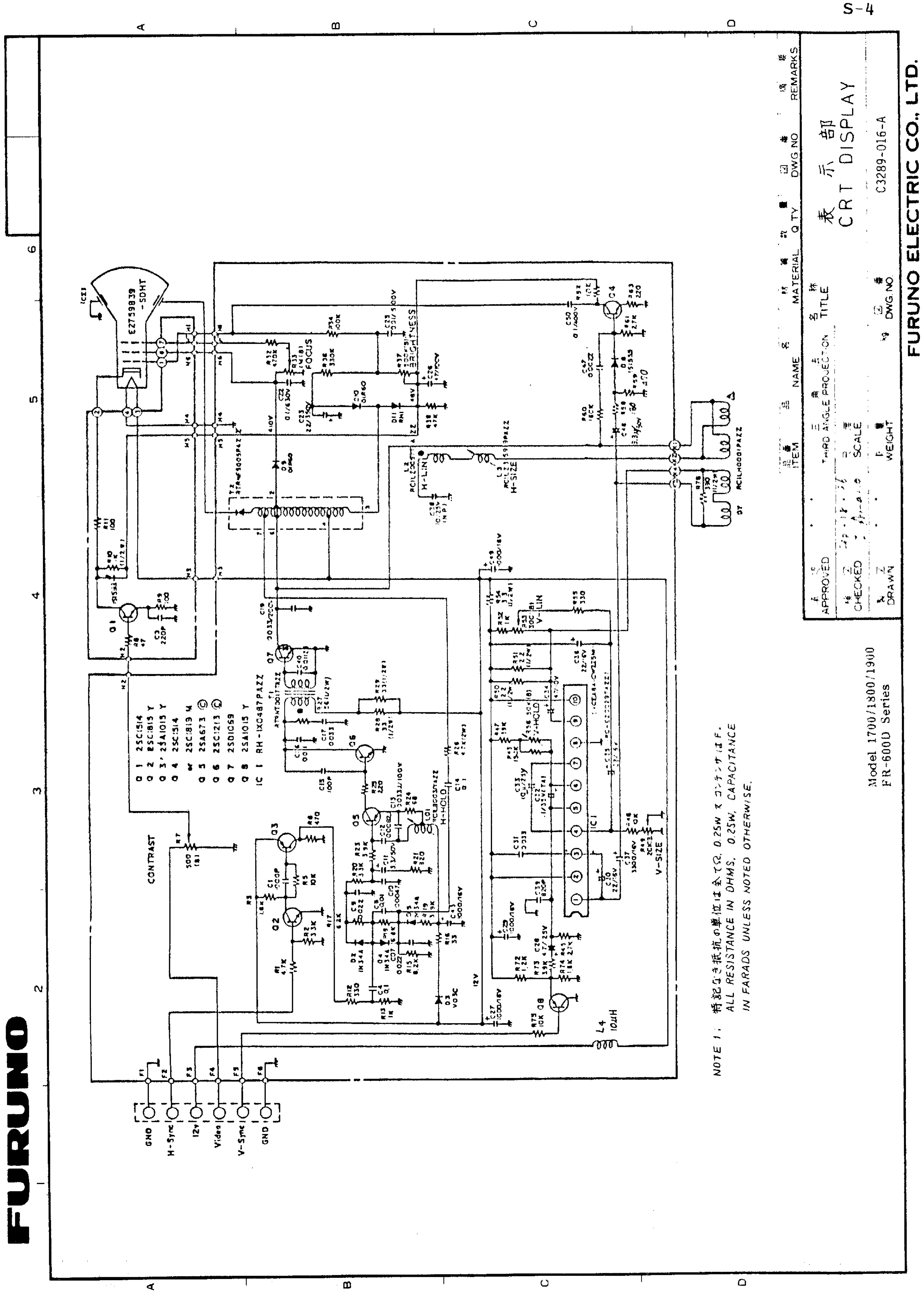
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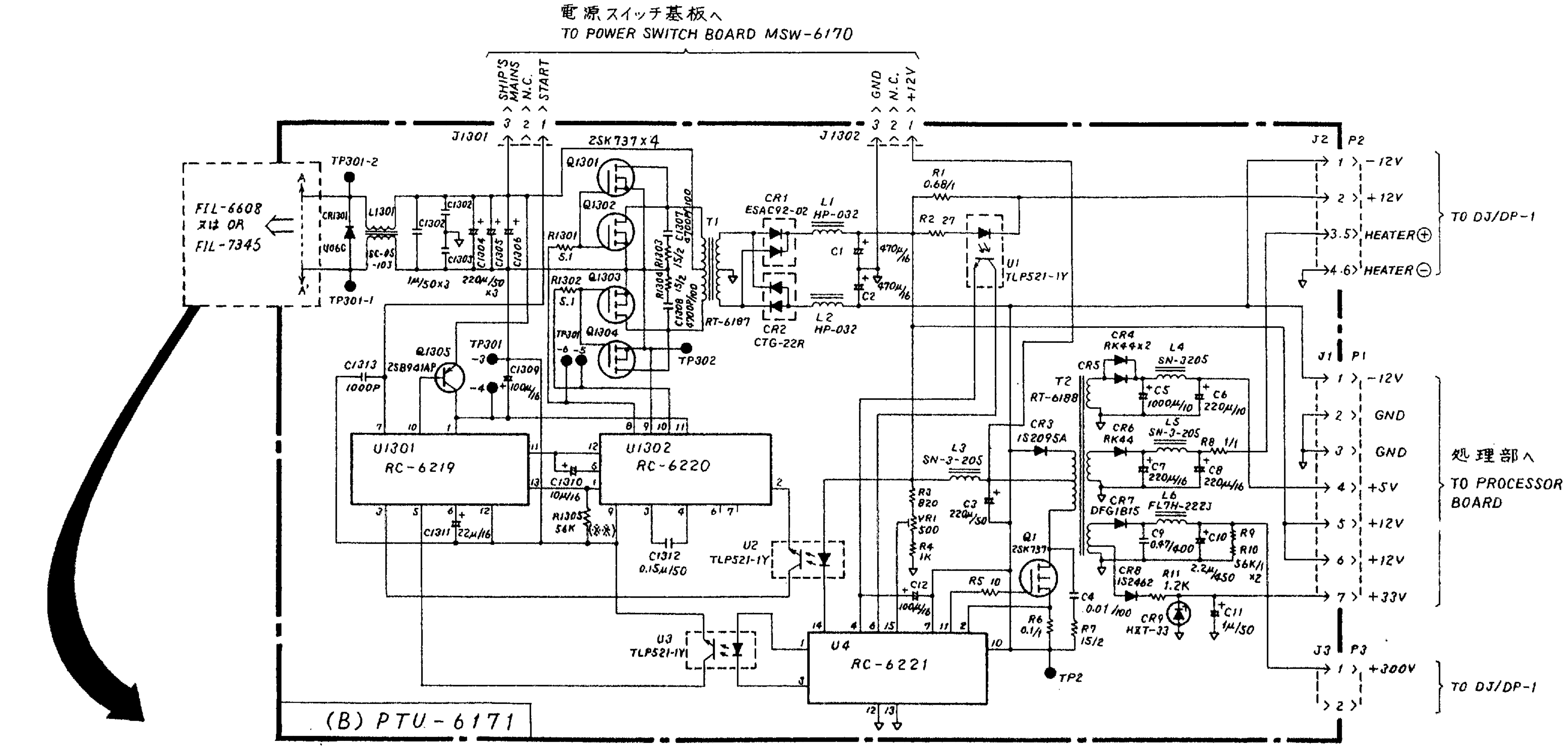


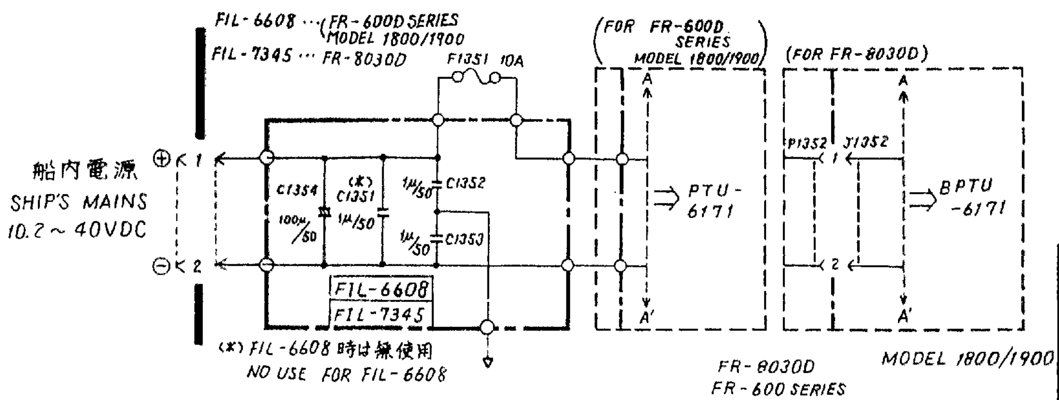

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| 承認 APPROVED | Nov. 17 '86 T. NAKANO | 名称 TITLE | ADJ-6398 プリセットコントロール PRESET CONTROLS |
| 検図 CHECKED | Nov. 17 '86 I. Amano | | |
| 製図 DRAWN | Nov. 17 '86 Y. Tomiyama | 図番 DWG. NO. | C3292-025-B |

FURUNO ELECTRIC CO., LTD.







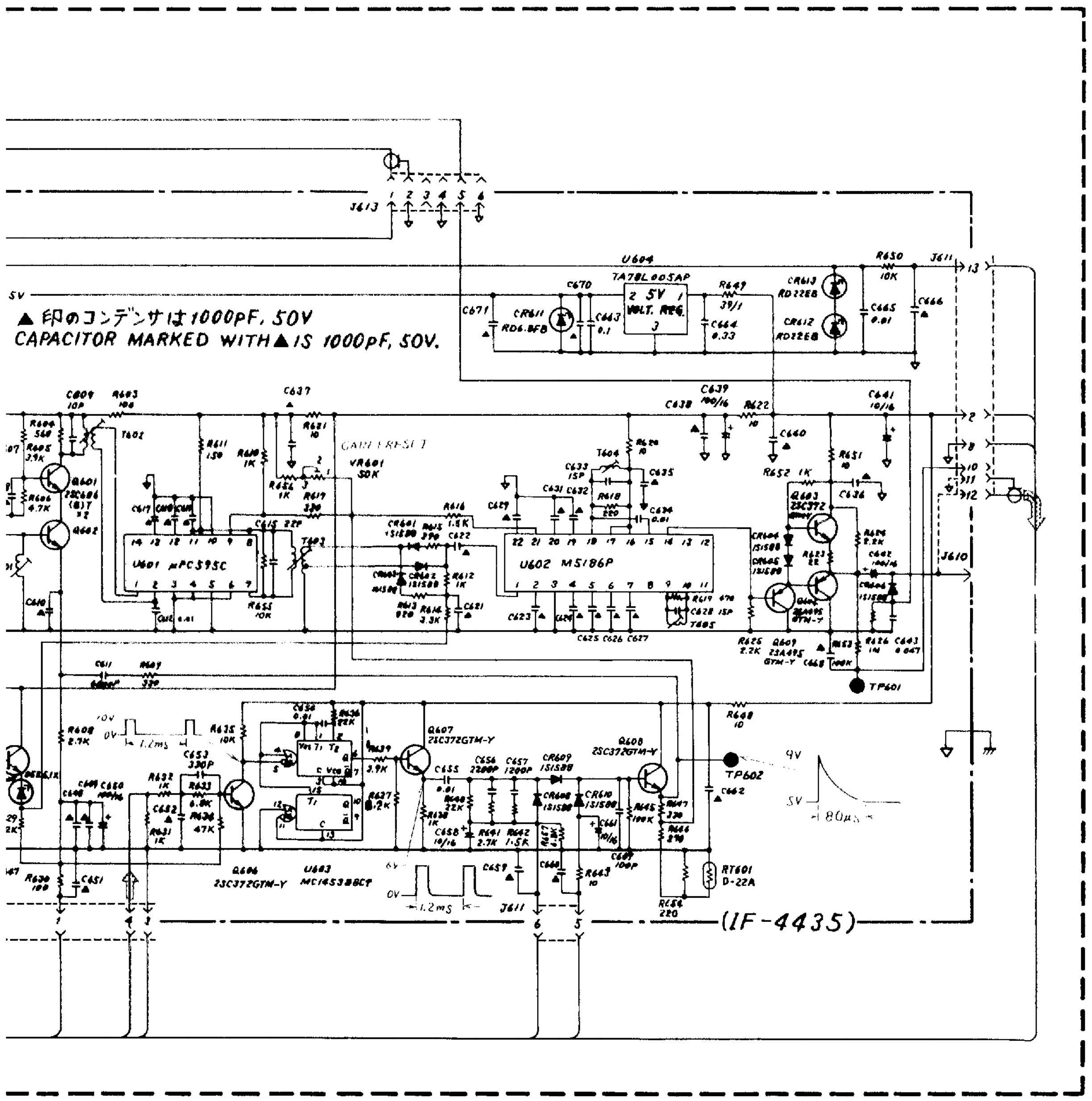

NOTE 1. 特記無き抵抗の単位は全てΩ, 1/4W又コンデンサはμF。
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
2. (※※) R1305はMODEL 1700では使用されない。
R1305 IS NOT USED FOR MODEL 1700.

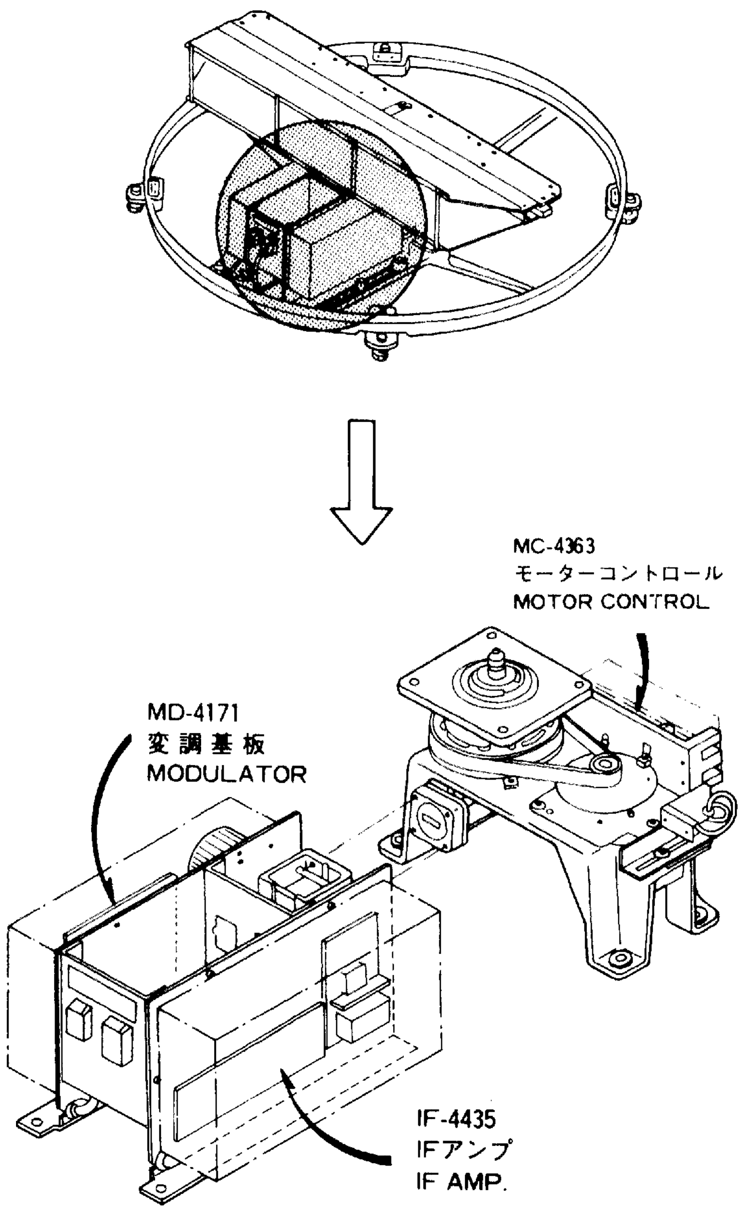
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| 検図 CHECKED | Oct. 12. '85 | 尺度 SCALE | |
| 製図 DRAWN | OCT. 8. '85 | 重量 WEIGHT kg | 図番 DWG.NO. C3289-008-J |

REV.: 1/86

FURUNO ELECTRIC CO., LTD

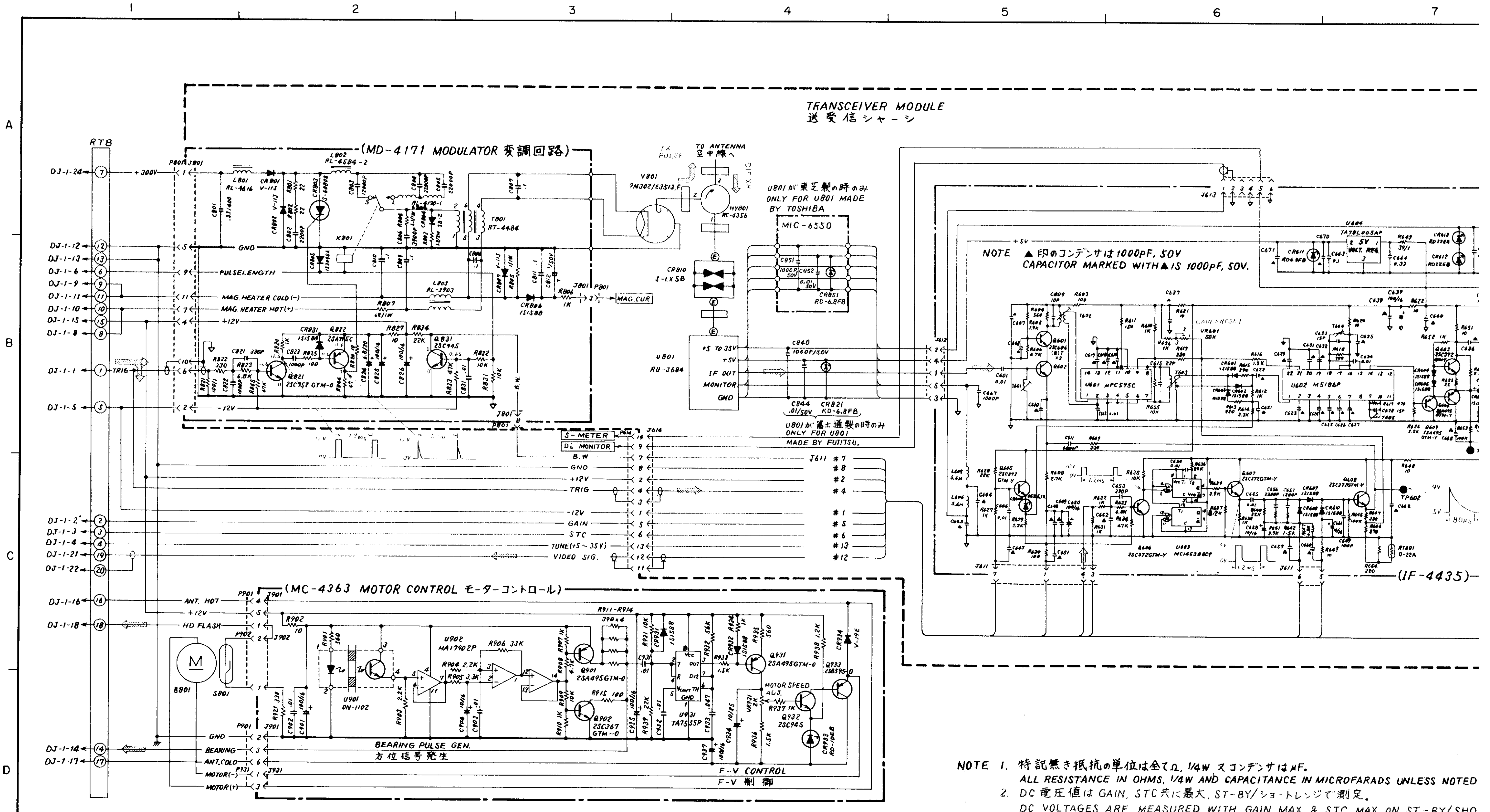



特記無き抵抗の単位は全てΩ, 1/4W ヌコンデンサはμF.
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
DC電圧値はGAIN, STC共に最大, ST-BY/ショートレンジで測定。
DC VOLTAGES ARE MEASURED WITH GAIN MAX & STC MAX ON ST-BY/SHORT RANGE.
波形図はGAIN, STC共に最大, 送信/3マイルレンジで測定。
WAVEFORMS ARE MEASURED WITH GAIN MAX & STC MAX ON TX/3 MILE RANGE.

| | | |
|---|---|---|
| FCR-902<br>FR-602D<br>FR-802D<br>MODEL 2400 | 名称 TITLE | 空中線部回路図<br>SCANNER UNIT |
| | 図番 DWG. NO. | C3255-008-G |

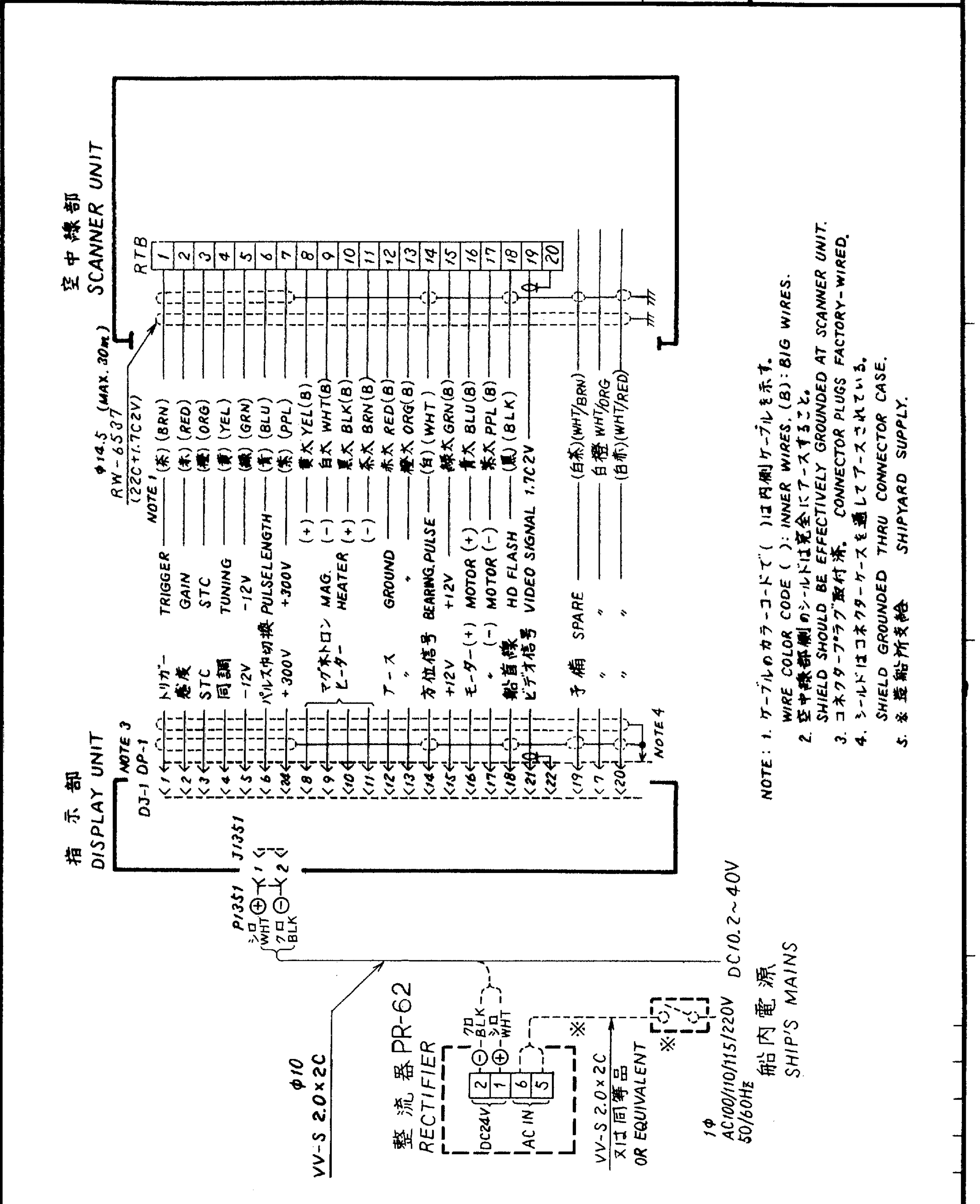
Rev.: 5/84, 3/85, 9<br>11/85, 9/86




NOTE 1. 特記無き抵抗の単位は全てΩ, 1/4W スコンデンサはμF.
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED
2. DC 電圧値は GAIN, STC 共に最大, ST-BY/ショートレンジで測定.
DC VOLTAGES ARE MEASURED WITH GAIN MAX & STC MAX ON ST-BY/SHO…
3. 波形図は GAIN, STC 共に最大, 送信/3マイルレンジで測定.
WAVEFORMS ARE MEASURED WITH GAIN MAX & STC MAX ON TX/3 MILE …

# FURUNO

S-7




FR-602D

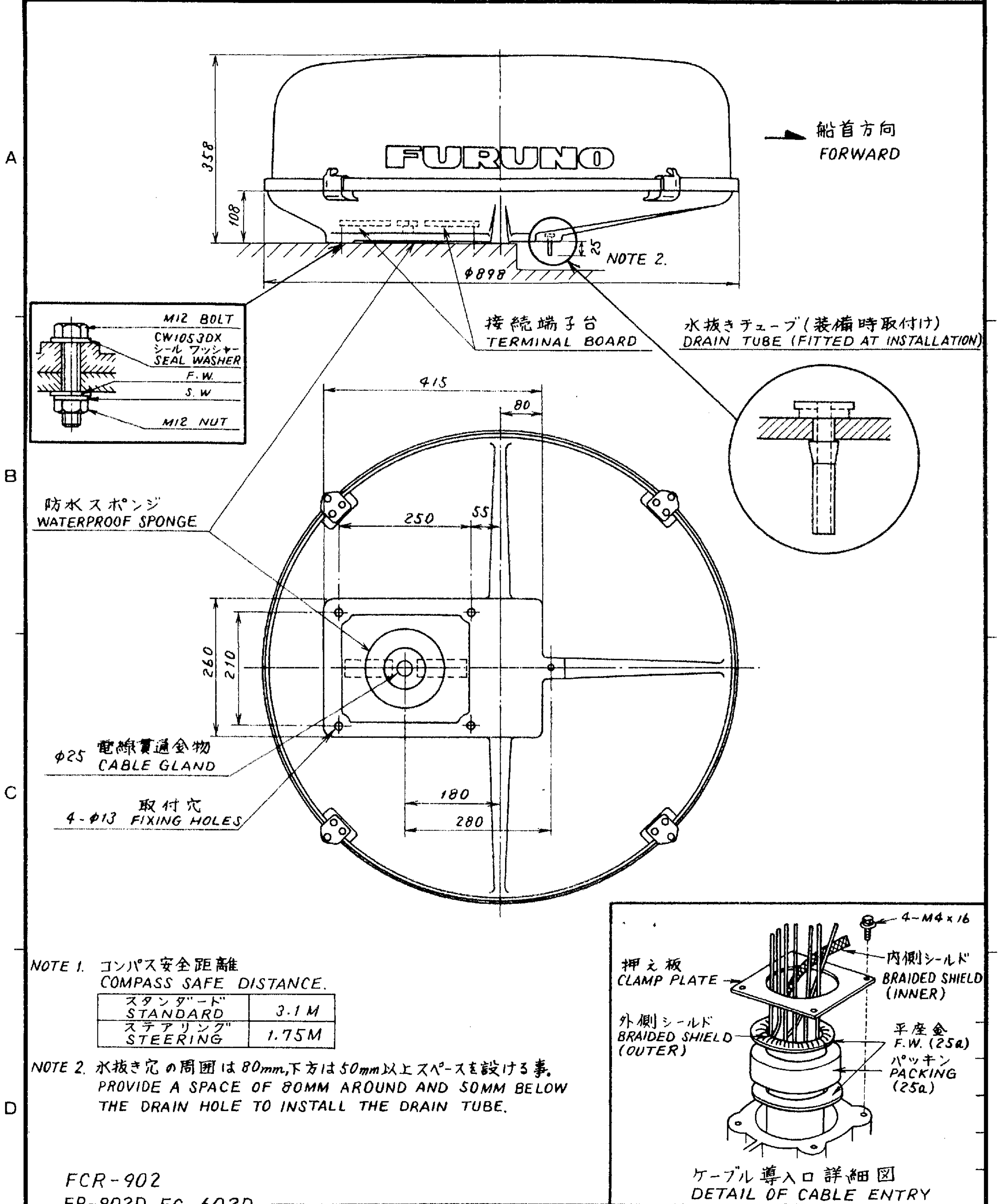
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| | | | |
|---|---|---|---|
| 承認 APPROVED | '86. 12. '86 | 三角法 THIRD ANGLE PROJECTION | 名称 TITLE 相互結線図 INTERCONNECTION DIAGRAM |
| 検図 CHECKED | June. 12. '86 | 尺度 SCALE / | |
| 製図 DRAWN | June. 12 '86 Tomiyama | 重量 WEIGHT kg | 図番 DWG.NO. C3292-013-B |

FURUNO ELECTRIC CO., LTD.

# FURUNO

D-1




FCR-902
FR-802D FC-602D
MODEL 1600/2400

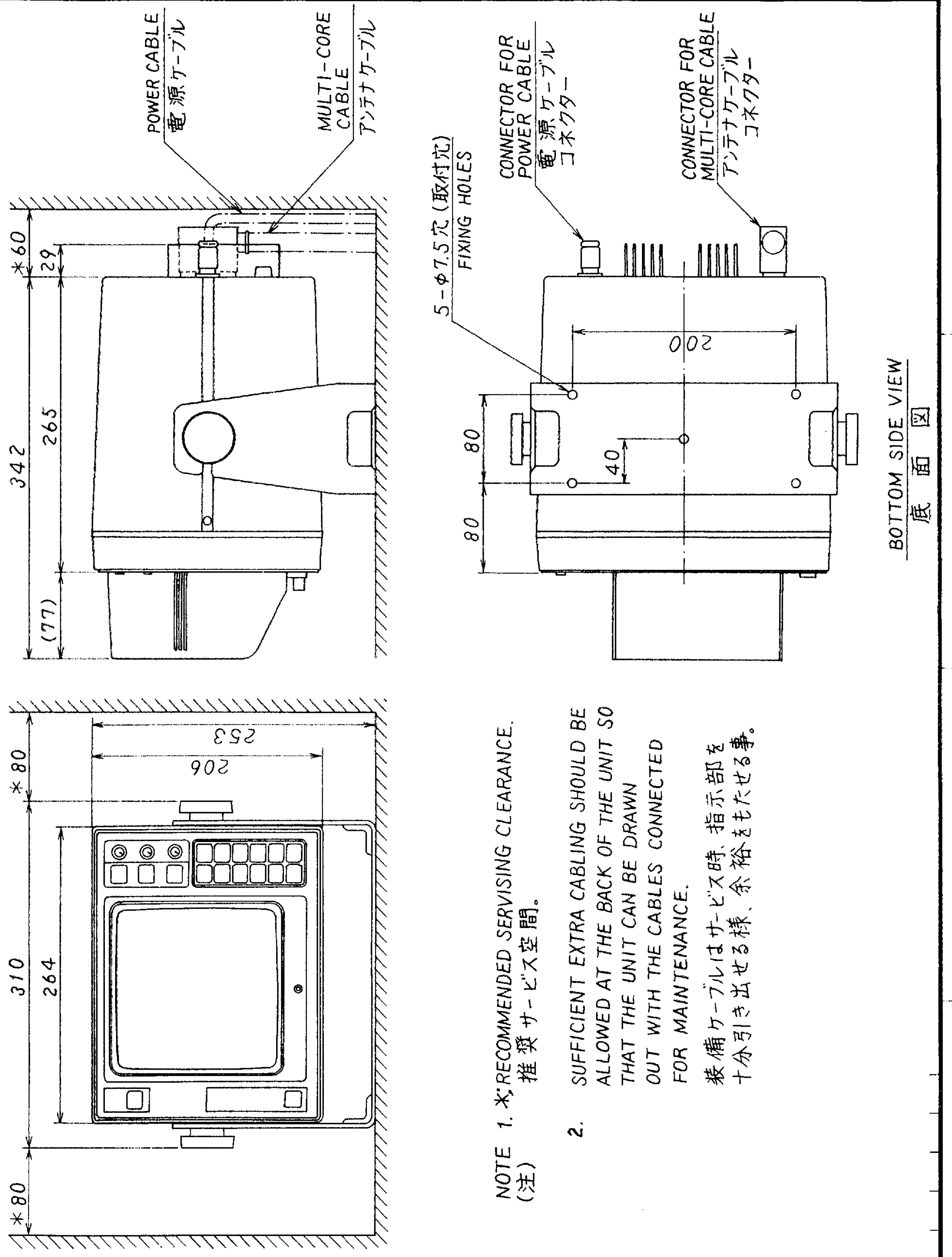
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| | | | |
|---|---|---|---|
| 承認 APPROVED | | 三角法 THIRD ANGLE PROJECTION | 名称 TITLE レーダー空中線部寸法図 RADAR SCANNER UNIT |
| 検図 CHECKED | Sht. 10. '86 | 尺度 SCALE 1/10 | |
| 製図 DRAWN | Sht. 9. 30 | 重量 WEIGHT 19 kg | 図番 DWG.NO. C3248-004-G |

FURUNO ELECTRIC CO., LTD.

FURUNO

D-2




FR-601D/602D/603D/604D

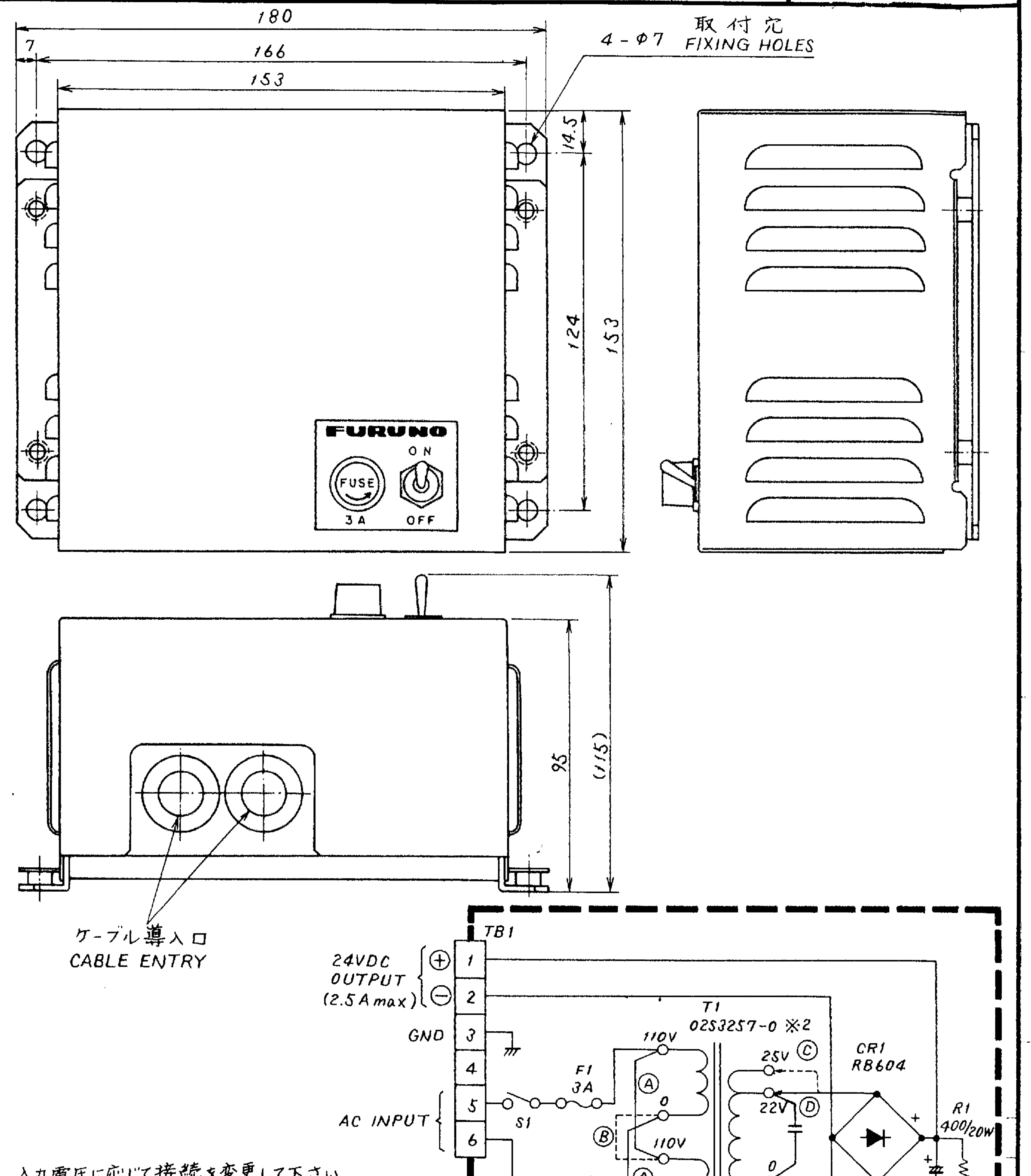
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| | | | | | |
|---|---|---|---|---|---|
| 承認 APPROVED | JUNE. 16 .'86 | 三角法 THIRD ANGLE PROJECTION | | 名称 TITLE | RADAR DISPLAY UNIT<br>レーダー指示部外寸図 |
| 検図 CHECKED | June. 16 .'86 | 尺度 SCALE | 1/5 | | |
| 製図 DRAWN | June. 13 .'86 Y. Tomiyama | 重量 WEIGHT | 6.9 kg | 図番 DWG. NO. | C3292-018-A |

FURUNO ELECTRIC CO., LTD.

FURUNO

D-3




入力電圧に応じて接続を変更して下さい。
CHANGE TAP CONNECTIONS DEPENDING ON SUPPLY VOLTAGE.

| | AC100V | AC110V | AC220V | AC230V |
|---|---|---|---|---|
| ※1 | Ⓐ | Ⓐ | Ⓑ | Ⓑ |
| ※2 | Ⓒ | Ⓓ | Ⓓ | Ⓓ |

| 品番 ITEM | 品名 NAME | 材質 MATERIAL | 数量 Q'TY | 図番 DWG.NO. | 摘要 REMARKS |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 承認 APPROVED | JUN. 14 .'84 | 三角法 THIRD ANGLE PROJECTION | | 名称 TITLE | PR-62 整流器外観図<br>RECTIFIER UNIT |
| 検図 CHECKED | | 尺度 SCALE | 1/2 | | |
| 製図 DRAWN | | 重量 WEIGHT | 3 kg | 図番 DWG. NO. | C5003-034-B |

FURUNO ELECTRIC CO., LTD.